ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Vol. XXVIII. No. 50.

TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK 529

TECHNICAL ARTICLES:

A Cantilever Highway Bridge with Curved Bottom Chords (*illustrated*) 530
Fast Run of the Philadelphia & Reading R. R. (*illustrated*) 530
Reports on a Sewerage System for Woonsocket, R. I. 531
Rails 60 ft. Long and Churchill Joints, N. & W. R. R. (*illustrated*) 532
The Steam Engine in Modern Civilization 533
The U. S. 12-in. Breech Loading Rifled Mortar (*illustrated*) 534
Strains in the Rims of Fly Band Wheels, Produced by Centrifugal Force (*illustrated*) 535
American Society of Mechanical Engineers 536
Sewage Purification in America (*illustrated*) 544
The Engineering Schools of the United States, XXXV. 545
A New Recording Pressure Gage (*illustrated*) 547
Statistics Showing Progress and Prospects of Railway Construction in the Far Western States (*with inset*) 547
Underground Wiring on Electric Street Railways 549

PERSONALS, NEW PUBLICATIONS, SOCIETY PROCEEDINGS 533-539

EDITORIAL NOTES 540

Address of President Loring to the Am. Soc. M. E.—Need of Night Watchmen at Railway Crossings—Typhoid Fever in St. Louis—Pressure on the Suction Side of Pumps.

EDITORIALS:

Railway Construction in the Far Western States 540
High Speeds on Railways 541
The Civil Engineers of the U. S. Navy 542

LETTERS TO THE EDITOR 542, 544

Designation of Points of Curvature—The First Quadruple Expansion Engines—Effects of Over Driving in Piles (*illustrated*)—European Street Car Practice—Transition Curves on Street Railways (*illustrated*—Wind Stresses in Iron Buildings—Observation of Rivet Values—Some Facts of Experience in Pile Driving.

CONSTRUCTION NEWS 549-552

Railways, Electric Railways, Elevated and Cable Railways, Horse and Motor Railways, Highways, Bridges, Tunnels and Canals, Water-Works, Irrigation, Sewers, Streets, Electrical, Contract Prices, Miscellaneous, Manufacturing and Technical, Current Price List.

Work on the interlocking switch and signal plant being put in at the railway terminal at the World's Columbian Exposition by the Wuerpel Switch & Signal Co., of St. Louis, Mo., is progressing rapidly. Mr. G. B. Ross, superintendent of construction, informs us that all the pipe in yard No. 2 is in and ready to be connected to the tower, which is a two story wooden structure 41 ft. 2 ins., by 21 ft. 8 ins. The machine in this tower will operate 70 levers. In yard No. 1 there are about 20 switches yet to pipe. This work will soon be completed. The tower in yard No. 1 is nearly ready to receive the machinery. When completed it will probably be one of the largest interlocking towers in the world. It is 76 ft. 6 ins.. x 21 ft. 8 ins. The machinery will operate about 100 levers. The transportation and terminal arrangements were described in our issue of Oct. 13, and we shall probably describe and illustrate the switch and signal plant in a later issue. A. Lapham is the General Manager.

The cost of laying 13,224 sq. yds. of fire brick pavemen in Wilmington, Del., during the fiscal year 1891-2, as given in the last annual report of the Street and Sewer Department, was $2.10 per sq. yd. Most of the paving was on the stone foundation, and most of it was tarred. Some of the paving which was not tarred was grouted. On the different streets the percentage of loss of bricks per sq. yd. varied from 1 9-10 to 4½%. Nearly all the brick used averaged about $18.50 per thousand in cost, but some were bought for $14, all delivered at Wilmington. Many other details of the cost of material, cartage and other labor, are given in the report. Mr. Francis McCloskey is Street Commissioner.

A floating 125-ton derrick has been built by Messrs. Cramp, the ship builders, of Philadelphia, at a cost of $100,000. It has a record of lifting a 75-ton boiler off the pier, towing itself 100 ft. and lowering the boiler into the hull of the cruiser "New York," in 25 minutes, with two men to operate it. The mast is 116 ft. high, is 3 ft. in diameter, made of steel inside braced. The supporting cone is also made of steel, is 65 ft. high and revolves on 42 4-in. steel balls, with another set of ball-bearings at the top of the cone, 51 ft. below the head of the mast, for lateral pressure. The lifting-arm is 65 ft. long, with a counter-balance arm 50 ft. long. These arms just surmount the cone and are made of built steel sections and supported by a series of steel cables from the masthead. A traveller carries the hoisting gear, which is fitted with 1¼-in. wire rope and 30-in. pulleys. The pontoon is iron, and is 69 ft. long, 62 ft. wide and 13 ft. deep. Water compartments are used for balancing the load.

The lake front litigation at Chicago has been decided against the Illinois Central R. R., the U. S. Supreme Court having affirmed the judgment of the lower court, which decided in favor of the local authorities, and held that the Illinois Central R. R. did not have a right to use the submerged lands along the lake front for wharves, piers, etc. The order of the court directs a modification of the decree so far as relates to certain piers heretofore constructed by the railway company, the Supreme Court directing that a judicial investigation be made to determine whether or not Piers 1, 2 and 3, near Chicago River, and the piers between 12th and 16th Sts. are or are not within navigable waters. If within navigable waters, the railway company is divested of its title to these piers..

The most serious railway accident of the week was a derailment Nov. 30 at Arkansas City, Ark., on the Missouri Pacific Ry. Spreading of the track is given as the cause of the accident. The baggage car and two passenger cars of a northbound train left the track and the two passenger cars rolled down a 12-ft. bank. About twelve persons were injured, two fatally.

A trestle at Winston, N. C., on the Norfolk & Western R. R., is reported to have given away under a freight train Dec. 1, and the engine and six box cars went down. The trestle was 200 ft. long, and was under repair.

A locomotive boiler explosion occurred on the Lehigh Valley Division of the Philadelphia & Reading R. R., at Shenandoah, Pa., Nov. 30. The engine was running down grade with a train of empty coal cars. The engineman was killed and the fireman badly scalded, and may die. The engine was a dirt burner with a Wootten firebox, and weakened staybolts are given as the cause of the accident. This road has had three or four explosions of this type of boiler, but the cause is said to be overworking and bad repair.

A portion of the dam of the Honey Lake Valley Land & Water Co., in California, has been carried away by the floods in Long Valley Creek caused by the recent heavy rains.

The new Mannlicher rifle, as tested by the Austrian Government, is 40 ins. long, has a 6½ mm. bore (0.37 in.) and is sighted up to 2,700 yds. range. The tests showed a rapidity of fire of 5 shots per second. To insert another 5-shot "clip" and to commence firing again consumed 1½ seconds. The inventor claims that 120 shots per minute can be fired.

A stone monolithic pillar, weighing 420 tons dressed, is being made at the Ashland quarries in Wisconsin, for the World's Fair. The stone has been broken from its bed and weighs 600 tons in the rough. How it is to be handled and transported to Chicago is not stated.

A device for coaling vessels at sea has been invented by Capt. P. B. Low, of Brooklyn, N. Y. Briefly described, a collier fitted for hoisting coal is to be fastened astern of a ship, either towed or while the ship is at anchor, and between this collier and the warship will be a wire rope so fitted with a compensating balance that the rope will be taut nomatter how the ships may roll, and yet without dangerous strain on the rope. Along this cable the coal would then be pulled in bags.

Armor-plate tests were carried out on Nov. 30 at the new Redington proving grounds established by the Bethlehem Iron Co., which made the plates tested. The plate tested was nickel-steel (not Harveyized), 10 ins. thick. The gun used wasan 8-in. caliber, with a 250-lb. projectile, with 60½ lbs. brown hexagonal powder, and a muzzle velocity of 1,400 ft. sec. Three shots were fired, with a resulting penetration of 10½, 10⅝ and 10 ins. No cracks were developed and the effect on the plate was a conical hole with a fringed rim about one inch high on the back of the plate. Two Holtzer shells and one St. Chamond shell were used, and in each case the projectile rebounded and fell about 25 ft. in front of the plate, and strange to say, in the same spot. The Holtzer shells were upset and developed a swell of from ¼ to ⅓ in. in the middle. The 23 barbette plates, 12 ft. high, of which one was tested, will be passed. These plates weigh 480 tons, and cost $350,000.

The problem how to telegraph between light-houses and the shore without wires has been solved, say London dispatches of Nov. 26. Since June last constant electric communication has been maintained between the Needles light-house and the shore without any direct metallic connection. Willoughby S. Smith, who has been in charge of the experiments, has reported to a royal commission on the subject. He says: "An ordinary submarine cable has been laid in Alum Bay to within 60 yds. of the Needles rock, where it terminates with its copper conductor attached to a small anchor. This anchor is in 5½ fathoms at dead low water. The shore end of the cable is attached to the signaling instruments, while to establish the circuit a simple earth plate is immersed in the water close to the shore on the light-house rock. Two strong bare wires dip into the sea about 10 yds. apart. These two wires are in connection with the signaling instruments in the light-house. Thus, through the intervening space of 60 yds. the men on the rock can call the attention of those on shore or vice versa by means of an electric bell, and communications can be established by means of a single Leclanche battery cell."

The Manhattan Elevated Railway Co. has made a proposition to the Rapid Transit Commission asking for an extension of the Ninth Avenue line down Cortlandt St. to the Pennsylvania R. R. ferryhouse. The Pennsylvania R. R. Co. is evidently in favor of the project, and Mr. Thomson, of that company, said that 53,000 persons crossed the ferry every day, and many were patrons of the elevated railways. A connection between the Sixth and Ninth Avenue lines at College Place was also discussed. The application for the Cortlandt St. line was withdrawn later, owing to strong opposition of the property holders.

The proposed Park Boulevard, to unite the Philadelphia City Hall Square with Fairmount Park, is being surveyed, so that reliable estimates can be made of the possible damage to private property. This thoroughfare would cut the streets diagonally, and be the first of a proposed system of diagonal boulevards in Philadelphia. J. H. Windrim, Director of Public Works, estimates the cost of constructing the Park Boulevard, inclusive of land damages, at $6,000,000.

The dynamite-thrower "Vesuvius" is to be again tested by a board of experts as to her value as a war weapon with her present equipment of three fixed pneumatic gun tubes. She has never yet been tried with shells charged with the 600 lbs. of dynamite called for, as the tests in Chesapeake Bay, of May, 1891, were with shells loaded with sand only. In the coming trial of 75 shots, a number of the shells are to carry 500 lbs. of high explosives. If she is not successful as a thrower of dynamite she will be at once converted into a torpedo cruiser.

The New York Steam Heating Co. cannot be a very successful enterprise commercially. In a letter to the New York "Tribune," Mr. W. C. Andrews, the President of the company, says that for eight years he has personally contributed $150,000 annually "to keep the steam company alive and the sheriff from its door."

A society of naval architects and marine engineers is to be incorporated soon in New York, and the committee on organization are sending out invitations for membership, and hope to hold the first meeting at the time of the naval review next spring. Among the men already interested are C. A. Griscom, Theo. D. Wilson, U. S. N., Charles H. Cramp, Geo. W. Melville, Geo. W. Quintard, Gen. Francis A. Walker, Wm. H. Webb, and Irving M. Scott. Mr. Wm. H. Webb, of New York, is chairman of the organization committee.

The Government Sanitary Office, of Germany, has issued instructions founded upon observations made during the recent cholera epidemic, to water-works using sand filters, with a view of preventing cholera infection as far as possible. Some of the instructions are, in effect, as follows:

As the water derived from sand filters is never entirely free of germs, and the capacity of the filters in removing micro-organisms from water is limited, the rate of filtration should not be increased beyond a certain limit. The downward rate of filtration should never exceed 100 mm. (3 15-16 ins.) per hour. Cities or towns having inefficient filtering plants will either have to limit the use of potable water, in which case the introduction of water meters is recommended, or construct additional filter plants. Clogged filter beds may be scraped to such an extent that a layer of sand of no less than 30 cm. (11.8 ins.) depth remains. The first supply of water derived from a fresh filter must not be used. The filtered water must be examined daily. If unusual large numbers or uncommon species of micro-organisms are observed, the water must not be used. The separate examination of the water derived from each filter is recommended.

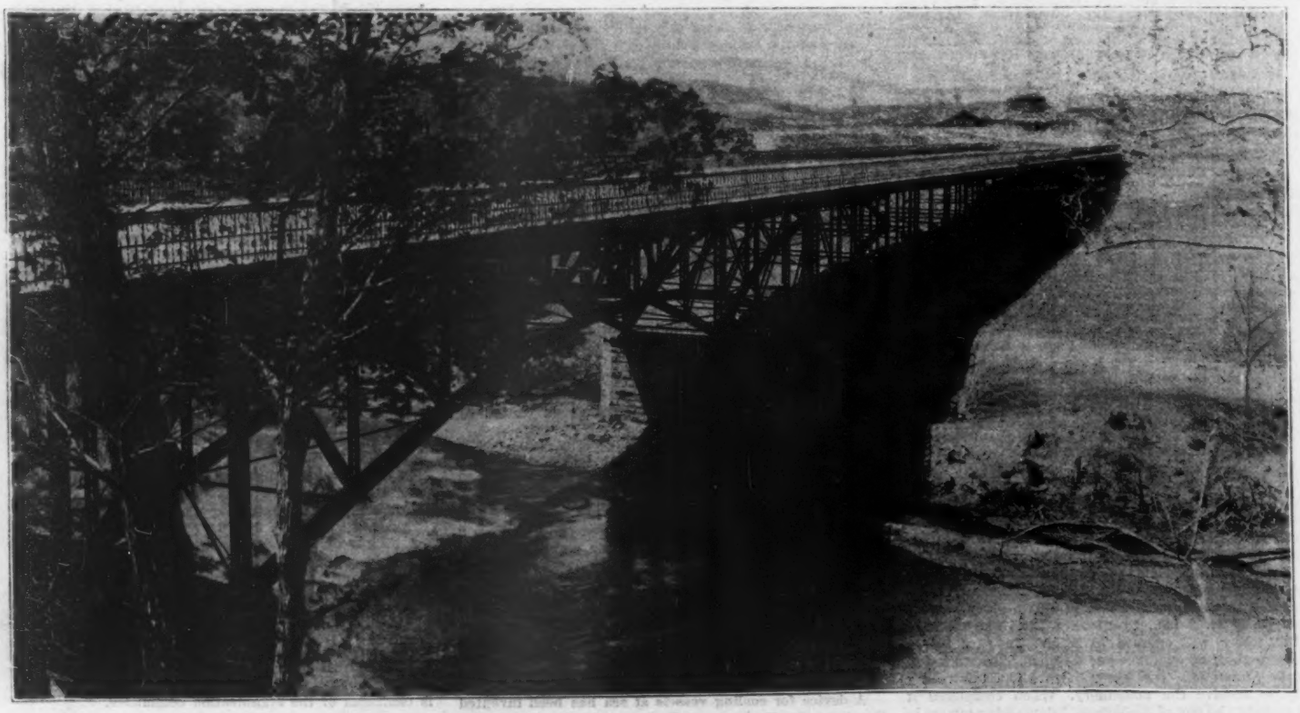
In transmitting electric power from Lauffen to Frankfort, 108 miles, the actual loss of energy was 18 to 20% in the triple process of transforming a current, of from 200 to 300 HP., into a current of high intensity but small volume, transmitting this current over naked copper wires on ordinary telegraph poles, and finally transforming it again into a current of ordinary pressure. This is the result of an elaborate long-distance transmission test made last October by a committee of experts, headed by Professor Weber, of Zurich. This report takes into account an initial loss of 8 to 10% in the generating dynamos, which can be saved by more perfect construction.

A CANTILEVER HIGHWAY BRIDGE WITH CURVED BOTTOM CHORDS.

We show in the accompanying engraving a general view of a cantilever highway bridge with curved bottom chords, recently completed for the Roanoke Development Co., at Roanoke, Va. This structure is the result of an effort on the part of its designer, Mr. Chas. C. Wentworth, Chief Engineer of the American Bridge & Iron Works, Roanoke, Va., to work out something more presentable from an artistic point than the ordinary straight-line truss bridge, which at the same time should not compare unfavorably with it in cost and stability. That the attempt has been remarkably successful as far as appearance is concerned we think our readers will agree, and will further add that a continued effort toward the same object by all bridge designers is a "consummation devoutly to be wish'd."

The bridge consists of three cantilever trusses with curved bottom chords and is 250 ft. long between anchorages. Each truss consists of two shore cantilevers, 50 ft. long each, two channel cantilevers 30 ft. long each, and a suspended truss 90 ft. long. The clear span is thus 150 ft. At one end the bridge connects with a long trestle-work approach. The general construction of the bridge and approach is quite clearly shown in the engraving and presents nothing of special interest. In regard to the stability and cost of the bridge the chief engineer writes us as follows:

> It is a very stiff structure and now carries electric cars over the central truss. At this locality it cost less than would two 50-ft. deck spans and one 150-ft. through span, which it would have been necessary to use to give clearance to the water, for the reason that there would have been but two trusses in the through span, necessitating much heavier floor beams, and that about 240 cu. yds. more masonry would have been required in the piers. The work was taken by us in competition with several truss designs and I only know that our bid was the lowest. I have made no estimates on truss designs for the locality. Exclusive of masonry the cost of the cantilever is about 25% less than would be a single truss span 250 ft. long.



CANTILEVER HIGHWAY BRIDGE WITH CURVED BOTTOM CHORDS, ROANOKE, VA; Chas. C. Wentworth, Engineer.

The first electrical mine tramway in Hungary has recently been introduced into the mines of Miszelfa-Czibaj, under the direction of Chief Engineer Labon, of the Board of Trade. The tramway is 1.24 miles long, and the electric locomotives used are able to haul 20 loaded cars, weighing 2,650 lbs. each, at an average speed of 9.95 miles per hour.

FAST RUN ON THE PHILADELPHIA & READING R. R.

American locomotives are approaching nearer and nearer to the ideal speed of 100 miles per hour. On Nov. 18 the highest railway speed ever attained was made by a Philadelphia & Reading R. R. express train between Philadelphia and New York over its own road to Bound Brook, N. J., and thence over the Central R. R. of New Jersey, as noted last week. The highest records were the two consecutive miles east of Fanwood, N. J., on the Central R. R. of New Jersey, which were made in 37 and 38 seconds respectively, or at the rates of 97.3 and 94.73 miles per hour. Up to this date the highest record was a mile in 39.4 seconds, or at the rate of 91.7 miles per hour, made by the same engine in February last. Indicator diagrams taken at that speed were published in our issue of June 9, 1892. Previous to that time the highest record was a mile in 39.8 seconds, or at the rate of 90.5 miles per hour, made by an engine and one car on the Philadelphia & Reading R. R. in August, 1891. These two former records have been mentioned in Engineering News of Sept. 12, 1891, and June 9, 1892. In another column we comment editorially upon high speeds for railway trains.

A description of this latest run was published by the Philadelphia "Ledger," a copy of which has been sent us by Mr. Vauclain, Superintendent of the Baldwin Locomotive Works, and from it we take the following particulars. The train consisted of a combination car, two passenger cars and a Pullman car. The weight was about 280,000 lbs. or 485,800 lbs. including engine and tender. The engine was an eight-wheel compound, as described later and carried 180 lbs. of steam at the start, which pressure was maintained pretty steadily. The train left the station at Ninth and Green Sts., Philadelphia, at 5:15 p. m., and Columbia Ave. at 5:20. Between Columbia Ave. and Wayne Junction the train ran 40 miles an hour, and reached Wayne Junction at 5:26. Three minutes were consumed here, and the train then started on its 85-mile run to Jersey City. Before much speed was developed there was a slow down for Tabor Junction, where the tracks join those of the old North Pennsylvania R. R. Between Tabor and Jenkintown the train was flagged, and the grade up the hill was 78 ft. to the mile, but high speed was maintained, five miles of the distance being covered in four minutes. Between Jenkintown and Langhorne, 13 miles, the schedule was 14 minutes. The start was made at Jenkintown at 5:39, two minutes late, and shortly after the train was under way a mile was made in 44 seconds. Between Somerton and Parkland, a distance of five miles, the longest time for a mile was 42 seconds, the first mile being run in 42, the second in 41, the two following miles in 40, and the last mile of the spurt in 42 seconds. The speed was between 86 and 90 miles an hour. The five miles were made in 205 seconds, which is said to beat all records for a five-mile run.

The engine behaved well, and the steam pressure was kept well up to 180 lbs. The vibration was not as marked as it was when the speed was 30 miles an hour. The run to Langhorne was made in exactly 12 minutes, arriving at 5:51.

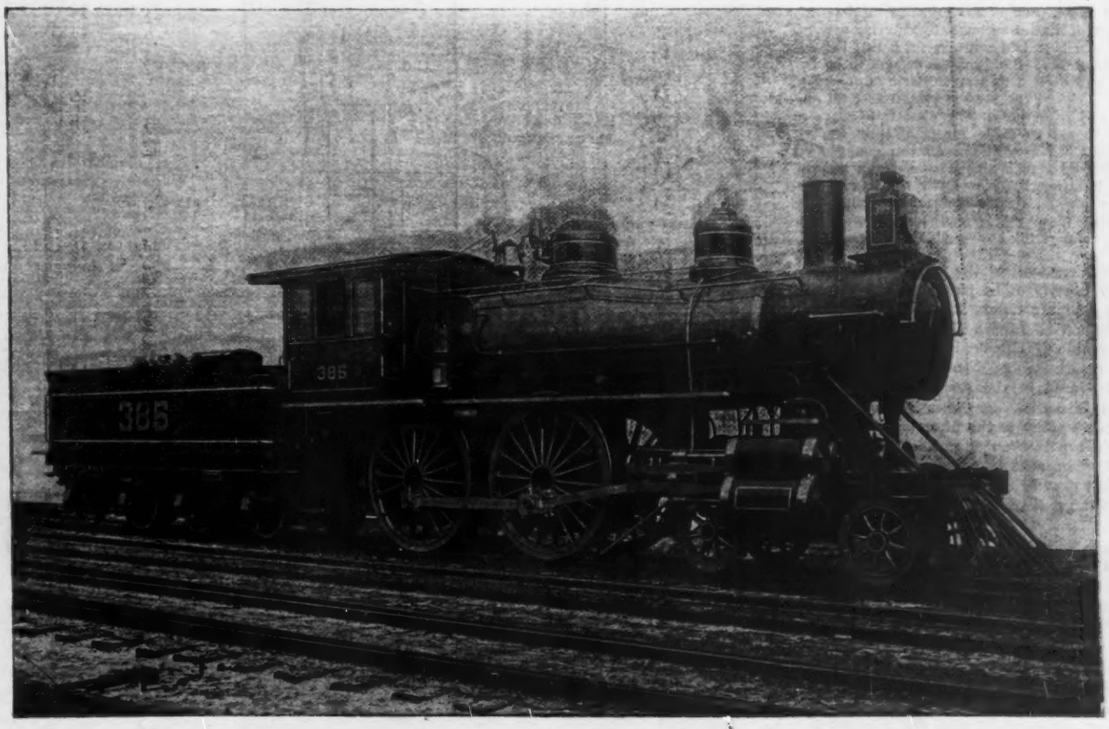
After passing Neshaminy all previous records were broken, and the engine reduced her own unsurpassed run of 39.4 seconds for a mile to 39 seconds. The stop at Langhorne occupied two minutes, and the train pulled out at 5:53 on time. To Yardley was 6.9 miles, and half the distance the grade was up hill 40 ft. to the mile. This run was made in 8 minutes, and the lay over was two minutes, leaving one minute late at 6:03. After leaving Yardley the run was slow, 15 miles an hour, over Yardley bridge, where water was taken from the track tanks. Trenton Junction was the next station, and the leaving time was 6:08½, 1½ minutes late. When the train left Pennington it was 3½ minutes late. It was flagged at Hopewell, where orders were received to look out for a coal train. Bound Brook was reached on time, however, but on pulling out the train was flagged, and Plainfield was reached three minutes late. After leaving Plainfield, the engine soon began to run at a furious rate. The automatic electric signals on the Jersey Central were favorable to the run, and the two miles between Plainfield and Fanwood were covered in considerably less than two minutes. The next mile beyond Fanwood was made in the record-breaking time of 37 seconds, and the next mile post was passed in 38 seconds. The time for the two miles was exactly 75 seconds. This made the greatest record for one and two miles, as the performance between Jenkintown and Langhorne did for five miles. The rest of the running was uneventful, and the train reached Jersey City two minutes ahead of time.

Mr. J. H. Olhausen, General Superintendent of the Central R. R. of New Jersey, states that the time was made between Westfield and Cranford,

where the line is straight for a number of miles. There is, however, a slight down grade of 27 ft. to the mile at this particular point.

The engine which made this record of 97.3 miles an hour, and the next best record of 91.7 miles an hour, was an eight-wheel engine of the Vauclain four-cylinder compound system, one of five engines for express service built by the Baldwin Locomotive Works, Philadelphia, Pa., for the Central R. R. of New Jersey. The number is 385, and she was handled by Henry Beck, engineman and David Blake, fireman. We are indebted to Mr. Vauclain for the accompanying cut and the following particulars of the engine.

Driving wheels, diameter	6 ft. 6 ins.
Truck wheels, "	3 " 0 "
Tender wheels, "	3 " 0 "
Wheel base, driving	7 " 6 "
Wheel base, truck	6 " 10 "
Wheel base, total	22 " 3½ "
Weight on drivers	88,400 lbs.
" " truck	35,400 "
" total	123,800 "
" of tender	82,000 "



COMPOUND EXPRESS LOCOMOTIVE, CENTRAL R. R. OF NEW JERSEY; Baldwin Locomotive Works, Builders.

(Record, 1 mile in 37 seconds = 97.3 miles per hour.)

Cylinders, h. p.	13 × 24 ins.
Cylinders, l. p.	22 × 24 "
Boiler, form	Wagon top.
" diameter	4 ft. 10 ins.
" height from rail to center line	7 " 8 "
" pressure	180 lbs. per sq. in.
Firebox (for hard coal)	11 ft. 0 ins. × 3 ft. 6 ins.
Grate area	38½ sq. ft.
Tubes, number	250
" diam. outside	2 ins.
" length	11 ft. 10 ins.
Heating surface, tubes	1,530 sq. ft.
" " firebox	166 "
" " total	1,696 "
Height from rail to top of smokestack	13 ft. 5½ ins.
Capacity of tender tank	3,500 galls.
" " coal space	7 tons.

The new iron bridge across the Delaware River at Easton, Pa., for the Central R. R. of New Jersey, has been tested and accepted. It is a double-track structure 1,020 ft. long. Four big Wootten engines, weighing about 80 tons each, were used in the test. The bridge was built by the Phoenix Bridge Co. It contains seven spans, and its erection was begun Sept. 8, 1891.

Work on the tunnel of the Cataract Construction Co., at Niagara Falls, is practically completed, and that on the feeding canal for the tunnel is being pushed. It is expected that power will be furnished to the Niagara Falls Paper Co. early next spring.

REPORTS ON A SEWERAGE SYSTEM FOR WOONSOCKET, R. I.

In its efforts to determine the best plan to follow in constructing a sewerage and sewage disposal system for Woonsocket, R. I., the joint special committee of the city council having the matter in charge, employed several different engineers and, in addition, a chemist, the latter to make a mechanical analysis of the soil for filtration.

The long and careful investigation of the committee and their employment of so many experts gives unusual interest to the various reports. In addition the several reports are of interest, first, in themselves, and, second, as showing the evolution of a design for a sewerage system.

The committee first secured a report from Mr. Chas. A. Allen, M. Am. Soc. C. E.

Mr. Allen recommended that a separate system be adopted which would provide for at least three times the present population; that the sewage of the Social district be pumped but that the bulk of the sewage go by gravity to the disposal area; that some of the sewers should be in tunnel; that partial purification be effected by chemical precipitation after which intermittent downward filtration should be used. Mr. Allen estimated that the annual cost of operating the purification works would be 35 cts. for each person using the sewers and that the cost of the whole system would be $456,605, exclusive of land damages.

The committee next engaged Shedd & Sarle, of Worcester, Mass., with Mr. J. Herbert Shedd, M. Am. Soc. C. E., of Providence, R. I, as consulting engineer, to do the preliminary work for a system of sewers

The report of Shedd & Sarle differed from Mr. Allen's in recommending that none of the sewage be pumped and that instead of tunneling natural water courses be followed for the main sewers and streams, and inverted siphons be used for river crossings; also that the purification be wholly by means of intermittent downward filtration. The cost of the system, as estimated by Shedd & Sarle, would be $587,140.

A conference was arranged between Mr. Allen, Messrs. Shedd & Sarle and Mr. J. Herbert Shedd which resulted in a joint supplementary report in which intermittent downward filtration on 56 acres of land lying on both sides of the Blackstone River, was recommended. The report advised preliminary treatment with lime in some form, provided the sewage should prove to be acid, and chemical precipitation as an auxiliary when the area available for filtration becomes overtaxed. It was thought that the land would dispose of about 50,000 gallons per acre per day, and that eventually there would be a daily flow of 3,000,000 gallons of sewage. It was also recommended that water from about 6,000 sq. ft. of roof per acre be admitted to the sewers for flushing, and that flushing tanks be used where necessary; also that no pipe with a diameter of less than 8 ins. be used in the system.

The joint report did not discuss the question of tunnels and no agreement on pumping the sewage of the Social district, or disposed of it otherwise, could be reached.

As a means of settling the disputed points the committee decided to submit all the reports to still another expert and selected Mr. Rudolph Hering, M. Am. Soc. C. E., of New York. This selection was approved by the engineers who had previously reported.

Mr. Hering approved of the points agreed upon in the joint reports and agreed with Messrs. Shedd & Sarle in recommending the use of siphons, as giving better alinements, but advised that instead of one siphon the size of the sewer at the point of crossing that several siphons of smaller pipe be used. Mr. Hering's discussion on this point is very interesting, as follows:

> These structures (inverted siphons) may be a failure or a success, according to the manner in which they are designed. It is due to this fact that we find a disagreement among some engineers regarding the merits of an inverted siphon for sewage conveyance and a disposition to use it as little as possible. My own examinations and experience have shown that with certain precautions, presently to be mentioned, no fear need be had of its satisfactory operation at all times.
>
> The prime requisite in a sewerage system, is to give the sewage a sufficient velocity so that the deposit of

the matter which is carried by it in suspension is prevented. As the velocity decreases a certain amount of material drops to the bottom. As it increases some is taken up again and carried further. But it requires a greater velocity to take up material once deposited than that which was just sufficient to let it settle. Therefore, with a regular oscillation in the flow we find that in sewers where any deposit once takes place this is apt to continue and accumulate, and to remove it an extra increase of velocity, or "flush," is required, produced by a larger influx of water, or by a temporary partial obstruction with a floating ball, or the deposit must be removed by mechanical means, (brushes, scrapers, etc.).

The plan presented to you in which siphons are extensively used, shows these to consist of a single pipe, generally of the same size as the sewer below it. Should this sewer ordinarily run one-quarter full, the siphon of course always running entirely full, we would then have a velocity in the latter of only one-fourth of that in the sewer. As in most cases the quantity of sewage will be less than this fraction, it is evident that much sludge will be deposited in the siphon. To avoid this objectionable condition, the siphon should consist of several pipes which together make up the full capacity of the sewer. One of these should be small enough to carry the ordinary flow of sewage at about the same velocity as that in the sewer above the siphon. The other pipe or pipes are to take the surplus during greater flows. Sumps are provided at the ends for the retention of matter accidentally entering sewers. Small siphons are best laid straight from end to end, to facilitate inspection; siphons large enough to be entered may as well be laid to a vertical curve.

In operating a siphon the sewage should first fill one of the pipes and afterwards flow over into another. Arrangements should be made for completely closing any one of them for inspection. As the changes of direction of flow through a siphon consume a certain velocity head, it is necessary to allow for this in the design, in order to avoid a retardation of flow above the structure. With these special precautions a siphon should work without giving any trouble whatever.

Regarding the removal of the sewage of the Social district by gravity or by pumping, Mr. Hering recommended pumping unless the general level of this district should be raised. Pumping would be especially desirable if chemical treatment should eventually be resorted to as then the sewage would need to be delivered to the disposal works at a sufficient level to permit its passage through settling tanks before going to the filter beds.

Mr. Hering's report was submitted to Messrs. Shedd & Sarle, who sent in a long report defending the proposed gravity outfall for the Social district and the flat grades which would thus be necessary.

The committee submitted for mechanical analysis 24 samples of sand and soil from the proposed filtration area to Mr. Allen Hazen, Chemist of the Lawrence Experiment Station of the Massachusetts State Board of Health. Mr. Hazen pronounces some of the samples unfit for use and for the others states how much sewage they could be depended upon to purify and how often the applications of sewage should be made.

Of the samples suitable for use, the amount of sewage which they could purify ranged from 30,000 to 80,000 gallons per acre daily and applications should be made to some daily and to the others three times a week. Mr. Hazen's report is accompanied by diagrams illustrating the size of the material of the various samples.

Mr. John W. Ellis, C. E., of Woonsocket, made two reports to the committee, the first one being an estimate of the cost of raising the level of the Social district and the second having been made after an examination of all the reports outlined.

In general Mr. Ellis agreed with the joint report and the report of Mr. Hering, and recommended pumping for the Social district, especially as he found that the district must be filled in to a greater depth than had been calculated for.

After considering all the reports received the committee recommended for adoption the joint supplementary report of Messrs. Allen and Shedd & Sarle; the use of siphons; and pumping for the sewage of the Social district. It also recommended that a committee be appointed to buy the necessary land for sewage disposal and that bonds be issued to pay for the land and meet the expenses of carrying out the report.

The committee began its work in 1890 and submitted its report in September, 1892. In May, 1891, the State Legislature authorized the city to acquire land for sewage disposal to make sewerage assessments and to issue $200,000 of bonds for the construction of a system of sewerage.

According to our news columns the City Council, the latter part of September, unanimously adopted the recommendations of its committee, as above.

RAILS 60 FT. LONG AND CHURCHILL JOINTS; NORFOLK & WESTERN R. R.

As noted in our issue of Aug. 18, the Norfolk & Western R. R. is laying 50 miles of track with rails 60 ft. long, on which a type of bridge joint is used which is the invention of Mr. C. S. Churchill, Engineer of Maintenance of Way. The form of the joint is clearly shown by the accompanying cuts. As shown in Fig. 1, it consists of two angle bars, with a short vertical web projecting below the base of the rail, and connected by a pair of bolts as in the Cloud joint, but while the Cloud joint affords no base support to the rail, Mr. Churchill uses a bridge plate which extends over the joint ties and has the sides bent down at the middle to bear upon the lower webs of the splice bars, as shown in the plan and cross-section, Figs. 1 and 2. Four ordinary track bolts hold the bars to the rail. The 60-ft. rails are laid on one of the mountain divisions, and Mr. Churchill informs us that the joints are doing excellent service, and says further:

"Notwithstanding the comparatively wide spacing necessary at the rail end to provide for expansion in rails of this length, the joints do not get low, but remain in service almost equally as well as the balance of the track. These fastenings are very much liked by engineers, supervisors and track foremen. There is no question in my mind but that it is the most perfect and complete rail fastening in use anywhere at this date. Our 85-lb. rail is rolled by the Maryland Steel Co., which has a very considerable order from us. The joint is made by the Diamond Steel Iron Co., of Wilmington, Del., and that company is my agent for introducing it on other roads. It is only within the last month that I have felt myself provided with facts in regard to this form of joint, sufficient to put the matter before the public. I recognize the fact that no railway cares for theories, but they wish the results of service."

In Mr. Churchill's original design for the joint, the bridge plate or base plate was of tee section, with a central rib on the under side, and the angle bars were of double section, as shown in Fig. 3. A number of joints of the original pattern were made of cast steel, and laid on a section of track having a grade of 1.7% and a number of 8° curves. The whole section was laid with 67-lb. rails on stone ballast, and equipped with this joint, while an adjacent section of a similar character was laid with new angle bars of the Norfolk & Western R. R. standard pattern. After being in service for more than a year the former section was found in much better condition than the latter. Mr. Churchill stated in a paper read before the Philadelphia Engineers' Club, in 1891, that no work had been required upon the bridge joint, while the angle-bar joints had required considerable tamping, and did not furnish as smooth a track as the new form of joint. The slight depression which occurs at all the joints of rails fastened by angle bars was absent from the former section of track, and under traffic the wave motion in the rails was carried through the joints practically as well as in the continuous rail. This Mr. Churchill thought to be one of the best features of his joint, as where this does not take place the joint is the weakest part of the track and will soon become low, producing a rough track which will require constant attention. These original trial joints are still in service and Mr. Churchill informs us that recent reports show that the joints remain in service with very little work, whereas angle-bar joints are continually getting out of line. A recent report shows that the actual cost of labor in maintaining the new joints is less than 50% of the cost of maintaining angle-bar joints laid on the same section of the road. The travel over this piece of track is 1,400 engines and 29,500 cars per month. The inventor thinks, therefore, that the trial of over two years is conclusive as to the value of the joint. His argument is, in substance, that the joint is practically as strong as the rail itself, and, therefore, the wave motion of the rail in traffic is carried through the joint, the same as if the track was an all continuous rail. Under this condition of affairs the joints are bound to remain in service, it being necessary only to provide sufficient support under the ties to take the extra jar due to the space between the rails at the joints. This argument has now, it is said, been reduced to facts proved from actual observation. Experience led to the modification of the joint, and it will be seen that in the new pattern all the parts are so designed that they can be manufactured easily by the use of rolls and forge.

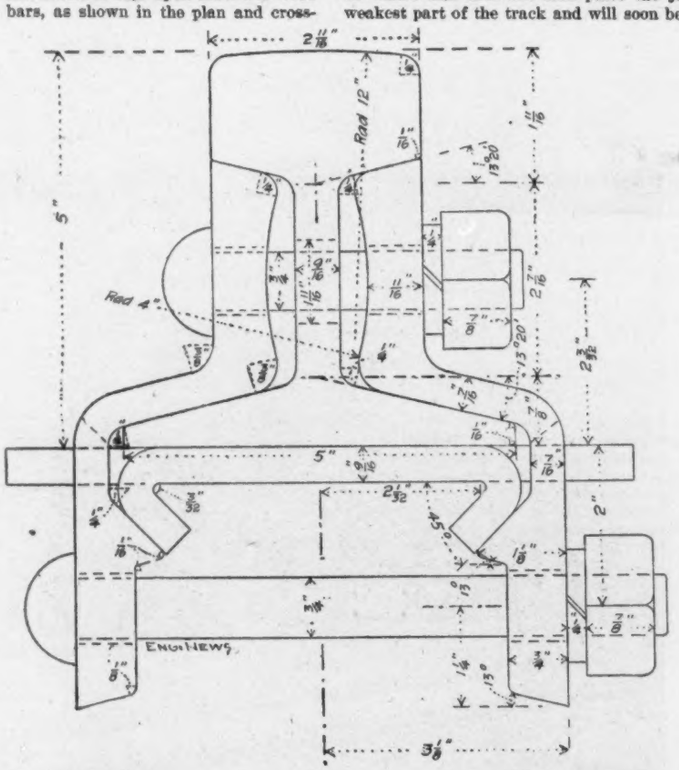


FIG. 1. CHURCHILL RAIL JOINT FOR 85-LB. RAILS; NORFOLK & WESTERN R. R.

In the paper above mentioned Mr. Churchill made the following remarks in regard to angle-bar joints:

Angle-bar joints, even when of the most approved pattern and placed upon heavy rails, show breaks in the angle-bars. The most recent observation I have made was on the Philadelphia, Wilmington & Baltimore Division of the Pennsylvania R. R., between Philadelphia and Wilmington. There I noticed rails averaging about 85 lbs. per yd., equipped with angle-bars extending entirely across two ties and provided with six bolts, and I will venture to say that fully one-fifth of all the angle bars were broken directly at the joint, the break extending from the top of the bar downward. The fact that the bars failed in this manner proves conclusively that they broke, not when the weight on the wheel was directly over the joint, but when the wheels were between the two ties adjacent to the joint, or possibly still further away. Since nearly all angle bars break in this way, it is of no advantage to lengthen them. What is wanted is an increase of section directly at the joint, but this increase cannot be secured, with the guarantee of a tight joint, unless the joint is carried beneath the rail.

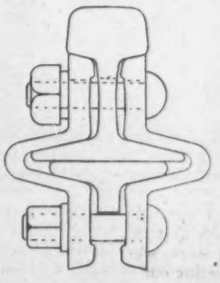


Fig. 3. Cross Section of Original Design of Churchill Rail Joint.

The new rail weighs 85 lbs. per yd., rolled in lengths of 60 ft., and the section is shown on the drawing. It is identical with that of the Baltimore & Ohio R. R. 85-lb. rail illustrated in our issue of July 18, 1891, and is very nearly identical with the mean section prepared from the individual designs of members of the Rail Section Committee of the American Society of Civil Engineers (Eng. News, March 21, 1891), the only differences being as follows:

	N. & W. Ins.	A. S. C. E Ins.
Height	5	5 1/8
Width of base	5	5 1/8
Width of head	2 11/16	2 5/16
Fishing angles	13° 20'	13°

The details of dimensions of the Norfolk & Western R. R. rail are given in the following table:

	Ins.
Height	5
Width of base	5
Width of head	2 11/16
Depth of head	1 11/16
Height of web	2 7/16

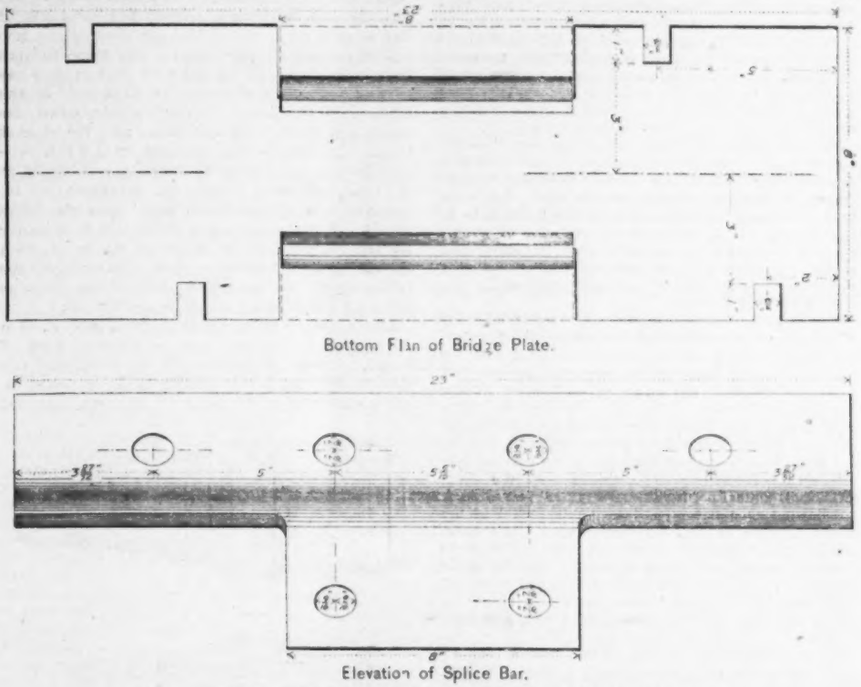


FIG. 2. BRIDGE PLATE AND SPLICE BAR OF CHURCHILL RAIL JOINT.

Depth of base	7/8
Thickness of web	9/16
Height to center of bolt hole	2 3/32
Radius of top of head	12
" top corners of head	1/4
" bottom corners of head	1/16
" top fillets	1/4
" bottom fillets	1/4
" corners of base	1/16
Side of head	Vert.
Side of web	Vert.
Fishing angles of head and base	13° 20'

THE STEAM ENGINE IN MODERN CIVILIZATION.*

By Chas. H. Loring, President Am. Soc. M. E.

The great historian who looks back a century hence upon the present era, with its numerous ramifications condensed by time into one focus, wherein the smallness of the field and intensity of the light enables him to see plainly what we now only dimly discern, will point out that the great underlying cause of the wonderful progress made by mankind during the last hundred years was the steam engine.

And why should this particular machine have produced such amazing results? Many other machines which preceded and accompanied its development are quite as ingenious mechanical combinations, and involved quite as much knowledge and skill in their conception and construction as the steam engine, but their effects were, comparatively, both local and trivial, producing scarcely a ripple on the current of human affairs. Had they never been, the world would have lost but little.

The answer is that the steam engine, with all its simplicity, is, what no other machine ever was, the creator of physical power, and this to so enormous an extent, at so small a cost, in so portable a form, and with such convenience of application, that it speedily revolutionized the economy of labor, and in so doing necessarily revolutionized all the conditions of man; for they have all been dominated by the labor question—the great bread-and-butter problem—since the primal curse was branded on the brow of the first man. It was to the relief of all mankind, in the struggle to find what to eat and wherewithal to be clad, that the immortal inventor of the steam engine gave to the world the finest solution of the problem it can ever hope to receive.

He builded wiser than he knew. He retired contented with the profits of his invention, and died without dreaming that he had placed on earth an infant Hercules whose club, with an ever-increasing might, would batter down the institutions of preceding ages; whose right arm, endowed with an ever-increasing power, would erect those of succeeding ages on foundations as different as strength differs from weakness, making possible the wonderful development of the man of the past into the man of the present.

All that man has he has obtained from the earth, and is the direct product of physical labor; and the sum of his possessions is directly as the quantity of this labor expended. So long as this was manual labor his possibilities were limited by the number of men available.

Here was the barrier that confronted the man of the past, and until the event of the steam engine, progress was necessarily difficult and slow; and the little which was made in the centuries during which he had plodded upon earth was local, confined to few localities, and at the expense of progress elsewhere.

The civilizations of antiquity were limited to a few cities, and were based upon slave labor, the slaves being drained from other places, which were thus doomed to deepening barbarism. The limit of possible slavery was the limit of the ancient civilization. When the maximum number of slaves who could be advantageously supported on any particular territory was reached, civilization stopped, except where direct robbery of other territory enabled it to maintain a fatuous existence; and the limit here was soon reached, for this was a system of "killing the goose that laid the golden egg."

The disgrace of the ancient civilization was its utter want of humanity. Justice, benevolence and mercy held but little sway; force, fraud and cruelty supplanted them. Nor could anything better be expected of an organization based on the worst system of slavery that ever shocked the sensibilities of man. As long as human slavery was the origin and support of civilization the latter had to be brutal, for the stream could not rise higher than its source. Such a civilization, after a rapid culmination, had to decay, and history, though vague, shows its lapse into a barbarism as dark as that from which it had emerged.

Modern civilization also has at its base a toiling slave, but one differing widely from his predecessor of the Ancients. He is without nerves, and he does not know fatigue. There is no intermission in his work, and he performs in a small compass more than the labor of nations of human slaves. He is not only vastly stronger, but vastly cheaper than they. He works interminably, and he works at everything; from the finest to the coarsest, he is equally applicable. He produces all things in such abundance that man, relieved from the greater part of his servile toil, realizes for the first time his title Lord of Creation. The products of all the great arts of our civilization, the use of cheap and rapid transportation on land and water, and of printing, density of population everywhere, the instruments of peace and war, the acquisition of knowledge of all kinds, are made the possibility and the possession of all by the labor of this obedient slave which we call the steam engine. He is no product of nature, but purely the creation of art. He works for all alike, and he works forever. His labor fills the earth, and makes manifest the latent virtues and intelligence of our race. The immense ameliorations of modern society are due to the same cause; and so great is the beneficence, that, without irreverence, the steam engine may be truly called the material savior of man.

We who were born under this benign influence but vaguely appreciate its value, and rarely recognize our obligations to it. Existing civilizations would be impossible without it, and if human ingenuity finds no substitute for it they will perish with it.

The steam engine is a machine which has been the prolific parent of other machines. It has caused the invention and construction of the immense plant of ingenious power tools employed in its own fabrication; it has caused the improvement of metallurgy as a science and of the various methods of metal manufacture as an art; it may be said to have created whole branches of important manufactures, and to have been the occasion of the invention of the immense mass of highly diversified machinery by means of which these manufactures are practiced; and, last and greatest, it has stimulated and directed the human intellect as nothing else ever has, and has done more to advance human nature to a higher plane than all that statesmen, generals, monarchs, philosophers, priests and artists have ever accomplished, in the vast interval which separates original man from the man of to-day. It has raised man from an animal to something approaching what a great intelligence should be, by simply placing in his hands a limitless physical power capable of application in every conceivable direction and to every conceivable purpose.

These words are no extravagant encomium; they are a simple statement of momentous facts, which, however, the mass of mankind seems so little to understand and appreciate, that I have ventured to give them record in a humble endeavor to prevent their being entirely overlooked, and with a hope of their eventual recognition.

* Annual address delivered at the November meeting of the Society.

Contemporaneous historians have but scantily drawn attention to the immense influence exerted upon modern history by the steam engine. They follow in the same well-worn ruts, giving dubious descriptions of battles, names of monarchs and of statesmen, lists of decrees and laws, no end of political negotiations and intrigues, and the whole array of puppets who seem to push the car of time, while they are only flies upon its wheels. The real shaping cause of the march of modern events and of the great industrial progress of the times has but trivial recognition in the literature which pretends to account for what has happened, or to predict what may ensue. One of the peculiarities of the genesis of the steam engine is, that it seems to have been more in the nature of a creation than of an evolution; for it was carried by its inventor, both as regards principles and practice, to a wonderful state of completeness. Very little has been added by his successors to his mechanical details or his various combinations of them. The invention seems to have nearly realized the birth of Pallas. The only modification in which he was not concerned is that of using the same steam in successive cylinders of increasing capacities, thus forming what may be termed, for the sake of distinction, the multiple cylinder engine as opposed to the single cylinder engine. The original multiple cylinder engine of Hornblower, brought out in 1781, and since known as the compound engine, and, by extension of the principle, as the triple expansion engine and the quadruple expansion engine, had thus a beginning almost coeval with the single cylinder engine of Watt. After much litigation it was declared to be an infringement on Watt's patents, covering the use of steam expansively, and it passed out of use. It did not, in fact, give any economic gain over the single cylinder engine, as the pressure of the steam was the same in both and only a few pounds above the atmospheric pressure, limiting the measure of expansion for maximum economy to about one and a half times. With this low pressure of steam, and for the small powers used in those days, there was no mechanical difficulty in developing the whole power in one cylinder with all the economy possible. To obtain higher economy, high pressure was a necessity, and pressure is solely a question of boilers. At that time the art of boiler-making was so inchoate that sufficient strength of generator could not be obtained for greater pressure, and the development of the steam engine could not progress much, if any, faster than the art of boiler-making; in fact, no one improvement in mechanics can advance much beyond the general front of what may be termed the industrial progress of the age. Aided by the improvement in the boiler-maker's art, the conspicuous advance which has been made with the steam engine is the direct result of the higher pressure of steam used.

The economic necessity for employing these higher pressures has brought into vogue again the multiple cylinder engine, which enables the steam to be used with a regimen not practicable with the single engine, and this regimen is attended with enormous economic gains. In the first place, what may be termed a "given quantity of pressure"—that is to say, the product of a given weight of steam by its pressure—is larger proportionately to the heat required to evaporate that given weight, the higher the pressure at which it is evaporated. The heat per pound of water vaporized from a given temperature, it is true, increases with the pressure, but the quantity of pressure produced under the greater pressures by a given quantity of heat increases in a higher ratio. The gain thus derived in the production of the pressure is very favorable.

Take 50 lbs. per sq. in. above the atmosphere as that usual with single engines of anything above small dimensions, and 150 lbs. above the atmosphere as an easily worked pressure with multiple cylinder engines, the gain in heat by the higher pressure used is about 1-12; a significant amount, but much less than what is additionally gained by the advantageous use of a greater expansion of the steam made possible by the greater pressure.

With the 50 lbs. pressure, no gain is obtained by expanding the steam more than about three times, while with 150 lbs. pressure the expansion can be advantageously carried to about six times.

The result of both of these economies is, that the multiple cylinder engine of the triple expansion kind produces the horse-power with about two-thirds the coal that the single cylinder engine does. Or, otherwise expressed, the single cylinder engine, under the given conditions, would require about 50% more fuel for a given power than the triple expansion engine. These are the mean figures for ordinary practice, which may be varied considerably for extreme and exceptional cases. The gain would be much greater than stated were it not that the higher pressure is accompanied by higher temperature, and therefore the gases of combustion must leave the boiler at a correspondingly higher temperature. Thus the economic vaporization of the boiler is less with the 150 lbs. pressure than with the 50 lbs. Obviously, too, the higher temperature is accompanied by greater heat radiations from all steam surfaces, and the higher pressure by greater steam leakages past the valves and pistons of the cylinders.

If the original steam engine was the greatest boon mankind has ever received, an increase of its value by one-third over its best development should add proportionately to the benefaction; and such is the industrial effect of the modern steam engine in its most advanced stage. The engineering world has "improved upon its heritages and vastly bettered its instruction." But it cannot proceed much further on the same lines, for with much higher pressure than has been already used the temperature of the steam would be too great to permit the metals to work satisfactorily on each other, while all the deducting losses would increase in a more than corresponding ratio.

The consequences of decreasing the cost of power by so large a fraction as one-third are very far-reaching, far beyond the mere cheapening to that extent of products already manufactured; for it allows other manufactures and other great works to be undertaken, which, with the reduced cost of power, become renumerative, but which at a higher cost would not have been undertaken. The benefits of cheapening power increase in a geometrical ratio; they radiate as from a center.

This great improvement in the steam engine, adapting it to higher possibilities and greater radius of action, has carried with it all matters germane to it, and not the least among these is the enormous impetus and extension which it has given to mechanical science and art everywhere, making the engineer, by whatever name or title his specific work may designate him, the most potent factor in the world's progress, and "in the great work"—quoting from one of my eminent predecessors—"of emancipating mankind from the trammels of his animal nature."

Following as a natural sequence this recital of the potent influence of the steam engine upon man's social and physical conditions comes the question: Is it to continue as the great power producing machine of the future? Can the inventive mind of man and his artful hand bring into being any other device as a substitute for it, that will do its work cheaper, better, and more handily?

To give answer to this is to say how it can be done, and as yet none is ready with a reply. Without doubt, there are still "more things in heaven and earth than are dreamed of in our philosophy," but in the contemplation of a solution of this question, that already dreamed of is the limitation of our resource. Already, we are beginning to avail ourselves of the enormous energy of water power, now going to waste through the convenience of electrical transmission and distribution, and the hand of the "Wizard" has drawn faint electrical energies direct from the combustion of fuel.

The winds and the tides and the rays of the sun have locked up within themselves enormous stores of power, waiting, perhaps, for the ingenuity of man to unbind and convert them to his uses.

But, when all shall have been realized which these as yet unused resources offer to man, when all man's present knowledge shall have ended in fruition, the steam engine, from its portableness, its convenience of application, and its self-containedness, will still remain man's valued servant, the grandest conception of the human mind, the great conservator of the human race.

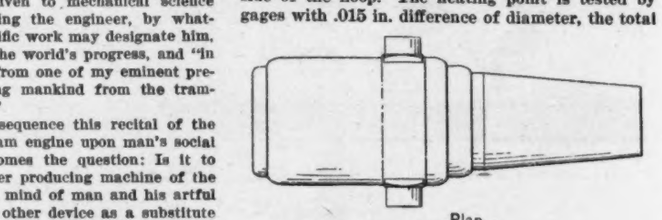
THE U. S. 12-IN. BREECH-LOADING RIFLED MORTAR.

In 1886 the United States Government adopted what is officially termed the "12-in. breech-loading, rifled mortar, cast-iron body, steel-hooped, 14¼ tons." Of these new guns 73 have been ordered at a cost of about $600,000. The cast iron bodies of 50 of these were made at the Builders' Iron Foundry, of Providence, R. I., and the same firm has the contract for finishing and assembling the whole lot. On Oct. 21, 1892, 37 of these guns had been delivered to the government.

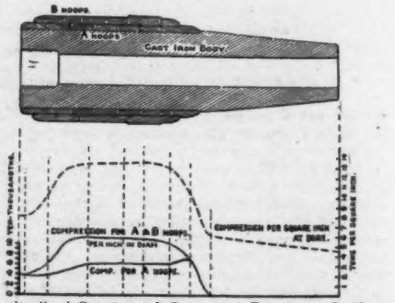
The cast iron bodies have a 12-in. bore, and are 129 ins. long and 31½ ins. in diameter. The diameter over the steel hoops, which are shrunk on in two rows, is 42½ ins. The castings for the bodies are made of charcoal pig cast vertically, breech down, and cooled by the circulation of water on the Rodman process. Test specimens cut from both muzzle and breech ends are to have an elastic limit of about 17,000 lbs. and a tensile strength of between 30,000 and 37,000 lbs. per sq. in. One-fifth of the entire casting is to be cut off as a sinking-head. The metal is melted in an air-furnace for six hours, to fuse it, and from two to six hours longer before pouring to bring the metal to a proper state. The amount of coal consumed is about 14,000 lbs., or 37% of the weight of the metal. The iron is tapped into a trough of fire clay leading directly from the furnace to the mold, and as soon as cast water is kept circulating constantly through the core. The top of the casting is covered with charcoal and a charcoal fire is built in the pit surrounding the iron flask, to keep the exterior from cooling too rapidly. In about 24 hours the core is removed and the water turned directly into the bore of the casting for a day or two longer.

This casting is next placed in the lathe and the bore is enlarged by several cuts of a reamer-like cutting tool, to a diameter of 11.8 ins. In the meanwhile turning tools are turning down the chase and cutting off test disks and the sinking head. The bore is next enlarged to 11.9 ins. The steel hoops, preparatory to shrinking, are faced at the ends and bored to 31½ ins. diameter; .003 in. being allowed for variation from exact size. The outside of the gun is now turned to a diameter slightly longer than the inside of the hoops, with the shrinkage difference varying slightly along the entire length to be hooped, the purpose being to place all hoops under nearly equal tension.

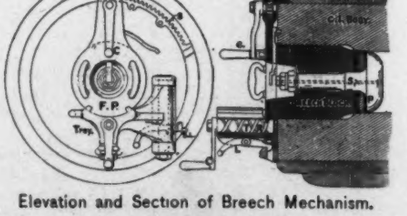
The hoops are then heated to about 500° F. by a mixture of air and city gas, in the proportion of 3 to 1, playing directly against the inside and outside of the hoop. The heating point is tested by gages with .015 in. difference of diameter, the total



Plan.



Longitudinal Section of Gun and Diagram of Hoop Compression.



Elevation and Section of Breech Mechanism.

UNITED STATES GOVERNMENT 12-IN. BREECH-LOADING RIFLED MORTAR.

expansion being about .09 in. in a hoop. When heated this hoop is slipped over the gun and forced against its neighbor by a 100-ton hooping press. A plane of water is then played on the forward part of the hoop and moved slowly backward until the entire hoop is cool. The joints made are so close that after the exterior is turned they can seldom be detected. When the first row of "A" hoops is in place, they are turned down carefully and the second row of "B" hoops is shrunk on in a similar manner and breaking joints.

The gun is then ready for the fine boring, which must be between 12 in. and 12.003 ins. in diameter, and straight enough to allow a test cylinder 11.997 ins. diameter and 42 ins. long to slip easily through the entire length of the gun. The rifling follows with 68 grooves, .379 in. wide and .07 in. deep with an "increase" pitch varying from one turn in 25 calibers to one in 40 turns. The breech mechanism is shown in the cut, and this is operated as follows: To load, the breech-block is unlocked

by turning the crank "C" to the right; the roller-crank is then turned, pulling out the breech-block and connecting parts onto the tray, which is then swung around out of the way. The shot is raised by a crane, shoved in, and the bag of powder follows. The tray is then swung back to its first position; the breech-block is run in by turning the translating roller-crank handle and locked by the revolving-gear handle. This latter movement uncovers the vent into which a primer is inserted.

In these mortars about 80 lbs. of powder will produce an initial pressure of 28,000 lbs. per sq. in. and give a muzzle velocity of 1,200 ft. per second to a shell weighing 830 lbs. This will insure a range of about 6 miles at 45° elevation. The shell is made of steel and contains about 30 lbs. of fine powder. The front end is turned to an ogival curve. The primer is at the back end of the shell and is projected forward against a fulminating cap when the object is struck. These guns are placed on carriages very similar to cannon carriages, except that the recoil takes place on a plane of 50° with the horizon.

STRAINS IN THE RIMS OF FLY-BAND WHEELS PRODUCED BY CENTRIFUGAL FORCE.*

By James B. Stanwood.

The strains developed in fly-wheels and pulleys are of an extremely complex nature, so that the numerous rules and formulas employed for proportioning them are almost entirely empirical in character. Experience and judgment have dictated largely the thickness of the rim, while the eye has played an important part in determining the shape and taper of the arms.

In text-books on machine design are found analyses of the strains in pulley arms due either to the pull of belt, the inertia of the rim, or the centrifugal pull on the arms due to weight of rim, etc. These text-books also state that the strength of the rim is not affected by its thickness as regards centrifugal force; for with an increase of thickness there goes an increase of weight with a corresponding increase of centrifugal force and area of cross-section to resist it. From this reasoning, wheels of good metal, perfectly true, and in good running balance, are only limited in speed by a periphery velocity, roughly assumed at about a mile per minute, or 88 ft. per second; a speed giving a very low strain (about 800 lbs.) per sq. in. of rim cross-section. Yet in view of these statements we find wheels bursting at low speed, others running safely at high speed.

In saw-mill practice, where belts travel at high speed, bursting pulleys have given so much trouble that heavier rims and arms for this service have become common when cast iron wheels are used. Sometimes even solid disk wheels are employed. In electric lighting plants many receiving and tightening pulleys have failed, causing serious or casual disaster, according to circumstances.

Within a few years very large fly-band wheels with wide, thin rims have taken the place of fly-wheels with square rims and have also been operated at very high speed. The writer knows of one case where the periphery velocity on a 17-ft. 9 in. wheel is over 7,500 ft. per min. In band-saw mills the blade of the saw is now operated successfully over wheels 8 and 9 ft. in diameter, at a periphery velocity of 9,000 to 10,000 ft. per min. These wheels are of cast iron throughout, of heavy thickness, with a large number of arms. Who would dare to operate an ordinary 9-ft. pulley at that speed? In shingle machines and chipping machines where cast iron disks from 2 to 5 ft. in diameter are employed, with knives inserted radially, the speed is frequently 10,000 to 11,000 ft. per minute at the periphery.

In view of the disasters so common of late to large band fly-wheels running at slower speed than these, it seems probable that the strains set up in wheels by centrifugal force have not been fully considered. Last spring the writer was one of three experts, called in to decide upon the cause of a serious fly-wheel accident. From the testimony submitted by a well known builder of large wheels, he was led to investigate a special strain developed by centrifugal force in band-wheel rims. This strain is due to the fact that all materials have elasticity, and stretch when under strain. The wheel in question was 22 ft. in diameter, 50 ins. face, and had a periphery speed of 5,000 ft. per minute. It was built in sections, as so many large wheels usually are (see Fig. 1.). The segments were secured to arms in such a manner that the segmental joints lay half way between the arms. This construction was criticised by the aforesaid builder, who indicated by a sketch (see Fig. 2) a better method. This formed the starting point for the investigation, which the writer wishes to submit for discussion.

A thin annular ring (Fig. 3) 1 in. wide and t ins. thick, revolving about a central axis A, is subjected to a simple tensile strain, similar in every respect to that found in a boiler shell, its amount per square inch T being $\frac{V^2}{10}$, when V equals velocity of rim in feet per second. This can be shown as follows:

Let r = radius of ring in inches.

R = " " " feet = $\frac{r}{12}$

V = velocity " " " per second.

The tensile strain T in pounds per square inch of rim section, due to bursting pressure per square inch p with a rim thickness t in inches, is:

$$T = \frac{pr}{t} \quad \ldots\ldots (1)$$

Each pound weight of ring exerts a bursting pressure due to centrifugal force

$$= \frac{V^2}{32.2\,R} \quad \ldots\ldots (2)$$

or for each inch in length of ring it will be

$$\frac{V^2}{32.2} \times \frac{12}{r} \times .261\,t = p \quad \ldots\ldots (3)$$

substituting in (1) we have:

$$T = \frac{\frac{V^2}{32.2} \times \frac{12}{r} \times .261\,t \times r}{t} = \frac{V^2}{10} \text{ nearly} \quad \ldots\ldots (4)$$

Under this strain the ring expands. If C be taken as the modulus of elasticity, this expansion will amount to $\frac{.314\,V^2 d}{C}$ in the circumference of the ring.

If arms are inserted in the ring, and are supposed at first to have no weight and to be rigid, with no elasticity, their effect will be to pull the expanded ring into its original diameter at the arms. It will then have the form diagramatically exaggerated by Fig. 4.

Under these conditions what will be the strain upon the ring? The ring between each arm resembles now a uniformly loaded rectangular beam fixed at both ends; it is also under a tensile strain of $\frac{V^2}{10}$ lbs.

The greatest strain in pounds per sq. in. F to which any fiber is subjected, can be expressed generally thus:

$$F = \frac{pl^2}{2t^2} + \frac{V^2}{10} \quad \ldots\ldots (5)$$

where l represents in inches the distance from center to center of arms, p the uniform load in pounds per square inch on the length l, and t = thickness of rim in inches. The width is assumed to be unity.

This formula can be expanded by substituting for p its value $\frac{V^2}{32.2} \times \frac{24}{d} \times .261\,t$ [from (3)] where d = diameter of ring in inches = 2r, and for l its value $\frac{3.14d}{N}$ ... (6) where N = number of arms. Then

$$F = \frac{3.14^2 d^2}{N^2} \times \frac{\frac{V^2}{32.2} \times \frac{24}{d} \times .261\,t}{2t^2} + \frac{V^2}{10} \quad \ldots (6)$$

$$= \frac{.95d\,V^2}{N^2 t} + \frac{V^2}{10} \quad \ldots\ldots (7)$$

$$\text{or } F = V^2\left(\frac{.95d}{N^2 t} + \frac{1}{10}\right) \quad \ldots\ldots (8)$$

$$\text{or } t = \frac{.95d}{N^2\left(\frac{F}{V^2} - \frac{1}{10}\right)} \quad \ldots\ldots (9)$$

But the ends of the arms do not remain rigid; the arms themselves expand longitudinally under the influence of their own centrifugal force, and they are also elongated by the strain outward imposed upon them by the expanding ring. In fact a compromise is effected; the arm stretches out to the ring, the ring yields in toward the arm, and the bending action in the ring depends upon this undeterminate amount. It appears, therefore, that the strain F cannot equal the value as derived by equation (8). By a careful comparison of rim thicknesses, as determined by equation (9), with good practice, t is found to be too large.

On the contrary, $\frac{t}{2}$ gives consistent results, and reasonably so, for roughly the arms can be assumed to expand one-half of the amount that the ring expands diametrically. When the arms are few in number and of large cross section, the ring will be strained transversely to a greater degree than with a greater number of lighter arms. To illustrate the necessary rim-thicknesses for various rim velocities, pulley diameters, number of arms, etc., the following table is submitted, based upon the formula:

$$t = \frac{.475\,d}{N^2\left(\frac{F}{V^2} - \frac{1}{10}\right)} \quad \ldots\ldots (10)$$

This is half the value given by (9), and the value of F is taken at 6,000 lbs. per sq. in.

Thickness of Rims in Solid Wheels.

Diam. of pulley in ins.	Velocity of rim. Ft. per sec.	Ft. per min.	No. of arms.	Thickness in ins.
24	50	3,000	6	⅝
24	88	5,280	6	1¼
48	88	5,280	6	1⅝
108	184	11,040	16	2 5/16"
108	184	11,040	36	⅛"

If the limit of rim velocity for all wheels be assumed to be 88 ft. per second, equal to 1 mile per minute, F = 6,000 lbs.; the formula becomes.

$$t = \frac{.475d}{.67N^2} = .7\,\frac{d}{N^2} \quad \ldots\ldots (11)$$

When wheels are made in halves or in sections, the bending strain may be such as to make t greater than that given above. Thus, when the joint comes half way between the arms, the bending action is similar to a beam supported simply at the ends, uniformly loaded, and t is 50% greater. Then the formula becomes

$$t = \frac{.712d}{N^2\left(\frac{F}{V^2} - \frac{1}{10}\right)} \quad \ldots\ldots (12)$$

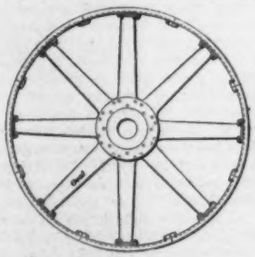


Fig. 1.

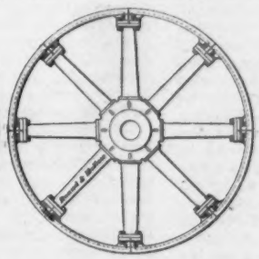


Fig. 2.

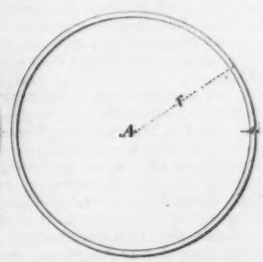


Fig. 3.

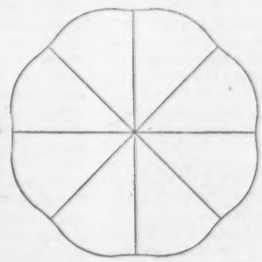


Fig. 4.

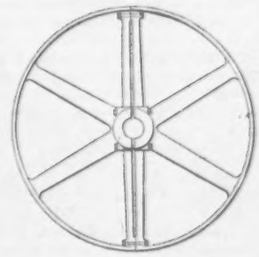


Fig. 5.

or for a fixed maximum rim velocity of 88 ft. per second and F = 6,000 lbs.,

$$t = \frac{1.05\,d}{N^2} \quad \ldots\ldots (13)$$

It is a fact that wheels do spring out at the joint when cast in halves or sections; for the writer has frequently tested them when they have shown this state of affairs. For this reason the construction for segmental wheels, shown by Fig. 2, is preferable to that shown by Fig. 1.

Wheels in halves, if very thin rims are to be employed, should have double arms along the line of separation (Fig. 5). Compare the thickness of the rim of a wheel made in segments or in halves, the joint half-way between the arms (Fig. 1), with the thickness of the rim as constructed in Fig. 2. For example, take a 20-ft. wheel at 88 ft. rim velocity per second, with 10 arms. When constructed according to Fig. 1, t must be 2½ ins.; according to Fig. 2, 1 11-16 ins.

Attention should be given to the proportions of large receiving and tightening pulleys. The thickness of rim for a 48-in. wheel (shown in table) with a rim velocity of 88 ft. per second, is 15-16 in. This should be carefully noted. Many wrecks have been caused by the failure of receiving or tightening pulleys whose rims have been too thin.

A word of caution should be given to engine builders and engineers. Wheels may be specified to be made too light in weight; for with a given diameter and

* Read at the New York meeting of the American Society of Mechanical Engineers.

* These are the calculated thicknesses for a band saw-wheel 9 ft. in diameter with 300 revs. per minute. The actual thicknesses as made were found to be 2½ ins. with 10 arms, and ⅝ ins. with 30—1½-ins. steel arms.

weight there is a minimum safe weight dependent upon the principles already set forth. Fly-wheels calculated for a given coefficient of steadiness are frequently lighter than the minimum safe weight. This is true especially of large wheels.

A rough guide to the minimum weight of wheels can be deduced from our formulas. The arms, hub, lugs, etc., usually form from one-quarter to one-third the entire weight of the wheel. If b represent the face of a wheel in ins., the weight of the rim (considered as a simple annular ring) will be

$$w = .82\ d\,t\,b \text{ lbs.} \quad (11)$$

If the limit of speed is 88 ft. per second, then for solid wheels

$$t = 0.7\ \frac{d}{N^2} \quad (11)$$

For sectional wheels (joint between arms)

$$t = \frac{1.5\ d}{N^2} \quad (13)$$

Substituting in (14) we have: weight of rim for solid wheels,

$$w = \frac{.57\ d^2 b}{N^2} \text{ in pounds} \quad (15)$$

Weight of rim in sectional wheels with joints between arms:

$$w = \frac{.86\ d^2\ b}{N^2} \text{ in pounds,} \quad (16)$$

Total weight of wheel: for solid wheel,

$$W = \frac{.76\ d^2 b}{N^2} \text{ to } \frac{.86\ d^2\ b}{N^2} \text{ in pounds} \quad (17)$$

For segmental wheels with joint between arms:

$$W = \frac{1.05\ d^2 b}{N^2} \text{ to } \frac{1.3\ d^2 b}{N^2} \text{ in pounds,} \quad (18)$$

This investigation has not the advantage of extreme accuracy, but it tends to show a relation which ought to be observed. The constants used may be modified by further experience.

The value of F = 6,000 lbs., is taken at one-sixth of Rankine's ultimate breaking strength of cast iron when under transverse strain. The factor of safety is, therefore, 6. It should be remembered that in wheels this factor can be rapidly diminished; thus the strain varies nearly as the rim velocity squared, and if the velocity is doubled, the strain is quadrupled, and the factor of safety is reduced from 6 to less than 2.

PERSONALS.

Mr. Jay Gould, President of the Missouri Pacific Ry. Co., Manhattan Ry. Co., etc., died in New York, Dec. 1.

Mr. Everett R. Reynolds has been appointed General Manager of the Long Island R. R., vice Mr. B. Norton, resigned.

Mr. James N. Warrington has opened an office in the Ashland Block, Chicago, to carry on a general practice in mechanical engineering.

Prof. Eugene Letang, for 20 years professor of architectural drawing at the Massachusetts Institute of Technology, died at Boston, Mass., Nov. 28.

Mr. J. J. R. Croes, M. Am. Soc. C. E., lectured on "Passenger Traffic in Large Cities," at Troy, N. Y., Nov. 30, before the students of the Rensselaer Polytechnic Institute.

Mr. J. Q. Hicks has been made Superintendent of Terminals of the Cleveland, Cincinnati, Chicago & St. Louis, R. R. Mr. George F. David will succeed him as General Yardmaster.

Mr. Hunter McDonald has been appointed Chief Engineer of the Nashville, Chattanooga & St. Louis R. R., vice Col. R. C. Morris, deceased. Mr. McDonald has been connected with the company for a long time.

Mr. Berrien Blackie, Assistant Engineer of the Nashville, Chattanooga & St. Louis Railway, died Nov. 28 at the City Hospital, Nashville, from burns by the explosion of a large quantity of fireworks in that city on Nov. 23.

Mr. F. W. Sargent, formerly engineer of tests on the Chicago, Burlington & Quincy Ry., and recently general agent for the Congdon Brake Shoe Co., of Chicago, is now superintendent of the latter company's brake shoe and iron department.

Mr. E. Sherman Gould sailed Dec. 3 for Havana, Cuba, to complete the work upon the Havana waterworks, of which Runkle, Smith & Co., of New York, are the contractors. Mr. Gould expects to be able to finish the works ready for the reception of water, early in the coming year.

Mr. D. Pottinger, General Superintendent of the Intercolonial Ry., has been appointed General Manager of the Canadian Government Railways, vice Mr. Collingwood Schreiber, who has been made Deputy Minister of Railways and Canals. Mr. Pottinger's headquarters will be at Moncton, N. B.

Mr. M. Tschirgi, Jr., has opened an office in Dubuque, Ia., to carry on a general engineering practice, making a specialty of furnishing plans and estimates for water-works, sewerage systems, etc. Mr. Tschirgi has recently completed a system of sewers at Pontiac, Ill., and is now engaged on a system of sewers at Le Mars, Ia.

Mr. Pemberton Smith is in charge of the equipment of the New York Central & Hudson River R. R. with the block system. He has been previously engaged on the Pennsylvania R. R. The new system will not be completed before spring. The block system is now operated between New York and Hudson, there being 90 signal towers in that distance. There will be 15 towers between Hudson and Albany and 205 from New York to Buffalo.

Mr. D. D. Sewall, formerly General Manager of the Consolidated Car-Heating Co., has been elected Vice-President. Mr. J. F. McElroy, formerly Mechanical Superintendent, has been appointed Consulting Engineer. Mr. J. H. Sewall, formerly Assistant General Manager, with headquarters at Chicago, has been appointed Superintendent of Construction, with headquarters at Albany. The offices of General Manager, Assistant General Manager and Mechanical Superintendent have been abolished.

Mr. Robert E. Peary, the Arctic explorer, in an interview with the Philadelphia "Press," thus outlines his plans for his next expedition: His purpose is first to determine the extent of the land masses north of Greenland proper, now found to be an island with its northern boundaries approximately fixed. He will explore these islands as completely as possible, and also determine the unknown east coast of Greenland from Independence Bay southward to Cape Bismarck. He will also determine the transverse profile of Greenland on a line extending from Cape Bismarck to Inglefield Inlet, on the northwest coast.

Dr. Ernest Werner Siemens, the famous engineer and electrician, died at Berlin, on Dec. 6. Dr. Siemens was born at Lenthe, in Hanover, in 1816, was educated at the Lubeck Gymnasium, and joined the Prussian Artillery in 1834. He applied himself with great zeal to the study of practical chemistry and the physical sciences, and became the inventor of the process of electro-gilding, of the differential governor and of the electric automatic recording telegraph. As member of a Commission of the Prussian General Staff for the introduction of the electric telegraph system in place of the optical telegraphs, he proposed in 1847 the application of subterranean conductors, insulated by gutta-percha, by means of a press invented by him for that purpose, which is still being used in the manufacture of cables. With the help of these insulated wires, he succeeded, in the spring of 1848, together with Professor Himly, in laying the first submarine mines with electric ignition for the protection of the harbor of Kiel, from the Danish fleet. In the same year he carried out the first great telegraph line in Germany, between Berlin and Frankfort-on-Main, and in the following year the subterranean line between Berlin and Cologne. Dr. Siemens left the government service in 1850, and devoted himself afterward entirely to scientific studies and to private enterprises. In 1847 he had already laid the foundation of the telegraph works afterward carried on by him under the firm name of Siemens & Halske, in Berlin, with later branch works in London and St. Petersburg, under the management of his younger brothers, William and Charles. Among his many and various achievements in matters relating to science and the technical arts must be mentioned as particularly noteworthy the invention and practical application of the quicksilver unit (Siemens' unit), by means of which exact and comparative measurements became possible for the first time; further, that of the gutta-percha press already referred to; that of the development of methods for testing underground and submarine cables and determining the position of faults in them; the invention of polarized relays; of the so-called Siemens armature, and of the dynamo-electric machine; the electric railway, and of numerous other inventions, such as the pneumatic dispatch tube system, and the Siemens alcoholimeter for registering the quantity of absolute alcohol contained in any alcoholic liquid passing through the instrument. Dr. Siemens was a member of the Prussian order "Pour le Merite," and the late emperor, Frederick III., of Germany, conferred upon him the patent of nobility. He was also the recipient of many other distinctions and honors. At the time of his death he was engaged in building an electric railroad in Berlin.

NEW PUBLICATIONS.

DECEMBER MAGAZINES.—The "Forum's" leading paper this month is a discussion of the defects of popular education, by President Eliot, of Harvard College. His statement that it is training the reasoning powers which is the chief duty of the schools rather than cramming the memory, is one which applies as well to the technical schools as to the common schools, though the latter doubtless stand in much the greater need of the criticism. There is a tendency, however, to require too much of the memory and too little of the judgment, even in the technical schools, and every teacher of engineering should read President Eliot's paper. Mrs. Van Rensselaer writes on the artistic success of the World's Fair builders, and gives them abundant praise. It is doubtless true that the great structures at Jackson Park will do good service next year in educating the public in art and artistic things. By the way, it will be interesting to compare the buildings at Jackson Park, when completed, with the structures at Fairmount Park, at which the nation wondered 17 years ago. The difference in the structures perhaps fairly typifies the progress which art and architecture have made in this country during that period. Two papers of great interest to the student of social science in this number are, "How Should a City Care for Its Poor?" by Professor Peabody, of Harvard, and a description of the excise system by which Sweden and Norway have in 12 years reduced by nearly one-half their consumption of distilled spirits. The "North American Review" has a paper on "Opportunities for Young Men in Jamaica," by the governor of that colony. He says frankly that Jamaica has no openings for young men without capital, but that those who have some resources can reap large profits there by the purchase of plantations. The island also possesses large deposits of ochre and pottery clay, which are as yet undeveloped. The great difficulty seems to be the lack of skilled labor, but one would think it might be met by importations from the United States. There is a brief paper entitled, "American Chauvinism," in which the writer says "the American people are inflated with a national vanity which creates among them a misconception of their country's relative value," and proceeds to specify particulars. Like many other critics he rather injures his argument by overstating his case.

The "Popular Science Monthly" has a translation from "La Nature," describing some recent applications of paper. Paper window panes, pulleys, flower pots, canoes, portable houses, and furniture are described, and the author even speaks of paper being used in place of iron for railway rails, but fails to give particulars concerning this application, which would be certainly remarkable if true. Another paper describes the experiments which have been made on inoculation as a preventive of cholera. According to the author's statements, there is good evidence that inoculation is as much a preventive of cholera as it is of smallpox, which gives strong ground for hope that a system of vaccination for cholera may yet be developed. This is a short paper on nickel and its uses, containing nothing with which engineers are not already familiar. This month's "Nineteenth Century" has an exceedingly interesting discussion of "The Labor Question," as it is presented in England, by Joseph Chamberlain. The scope of the paper is broader than its title implies, comprehending all the modern demands of the labor party.

We expect little "solid reading" in the holiday numbers of the literary magazines, and are not disappointed. Those who read with interest Mr. Hitchcock's paper on Chinese railways and telegraph lines, in our issue of Nov. 17, should read in this month's "Harper's" Mr. H. B. McDowell's description of some Chinese characteristics. In "Scribner's," Mr. F. D. Millet describes the decoration of the Columbian Exposition, in a finely illustrated article. The "Century's" helpful paper by Rev. Washington Gladden, on the "Problem of Poverty," is most appropriate at the Christmas time; while those who are fond of the records of adventure and daring will not miss Archibald Forbes' paper on "War Correspondence as a Fine Art."

TABLES AND MEMORANDA FOR ENGINEERS.—By J. T. Hurst. 11th edition. New York: Spon & Chamberlain. 64mo, pp. 135. 40 cts.

This is probably the smallest technical work published, occupying less space in the vest pocket than a watch. It is quite a useful little pocket-book, as we have stated in reviewing earlier editions, and contains a surprising amount of information for its size. The limit to its value on this side of the water is that it is based exclusively on English practice, but most of its contents are of common application on both sides of the ocean.

DIE ELEKTRISCHEN ACCUMULATOREN UND IHRE VERWENDUNG IN DER PRAXIS. (Electric Storage Batterics and their Practical Use.) By J. Sack, Telegraph Director. Vienna, Pest, and Leipsic. A. Hartleben; 12mo, pp. 256; 95 cuts, 3 marks (70 cts.).

This is another volume (XLV.) of Hartleben's electro-technical handy literature, which contains some excellent special manuals. The author has endeavored to describe very fully those systems of storage batteries which have so far proved efficient and are practically applied; the older types and the more recent systems of storage batteries, which as yet have not been put to practical test, are only given a secondary place. The principle of storage batteries is very clearly illustrated in the introduction. A special chapter is devoted to their practical application as storage batteries employed in electric light central stations and smaller electric lighting plants, with notes as to their cost; accumulators for lighting vessels and cars or for sup-

plying motion, and accumulators used in telegraphy, metallurgy and surgery. The illustrations, are very neat and good, as in so many other German technical books. We can warmly recommend the book to those desiring information on its subject matter, as one of the most complete treatises on it known to us.

SOCIETY PROCEEDINGS.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—November meeting. The meeting opened Tuesday, evening, Nov. 29 with a very full attendance. Pres. Chas. H. Loring delivered his annual address, reprinted in full in another column, after which a collation was served and the evening passed in conversation.

The morning (and only) session of Nov. 30 was passed in listening to the annual reports and in reading and discussing Mr. F. H. Daniels' paper on an "Interesting Boiler Explosion," which we shall reprint in another issue. The afternoon was passed in conversation at the society house or in local excursions, of which a long list was given for the members to choose from, and the evening in a very successful and largely attended reception and conversazione at Sherry's.

The annual report of the council showed that seven business meetings had been held during the year. It had considered favorably a proposition that the secretary keep on file a record of patents taken out by members and had arranged to take charge of the Mechanical Engineering section of the World's Fair Congress. The council also asked engineers to co-operate in a movement to do honor to the memory of G. A. Hirn, at Colmar, Alsace, his native place. It is proposed to have some one in attendance at the rooms of the society next year, speaking several of the European languages, to receive and render all possible assistance to any foreign engineers who may be en route to the Chicago Exposition. An invitation to several of the foreign societies to visit this country in a body is also contemplated. For maintaining the engineering headquarters at Chicago, $1,500 has been already subscribed, but $1,500 more is needed. An amendment to the Rules, permitting the council to remit the dues for life membership of any member of ten years' standing was proposed.

The council passed favorably on 180 applications for membership last year; 21 members resigned for various reasons; 17 members died. The present membership is:

Honorary members	17
Life members	39
Members	1,273
Associates	68
Juniors	211
Total	1,569

The tellers reported 64 members, 6 associates and 24 juniors elected on the ballot canvassed at the meeting.

A congratulatory address to John Fritz, Ex-Vice-President of the society, and, as our readers know, one of the founders and ablest managers of the American steel industry, was read, with a feeling response from him.

The report of the Finance Committee, showing a very healthy condition of the Society's affairs, was in substance as follows:

Receipts.		Expenditures.	
Initiation fees	$3,880	Printing, stationery	2,123
Annual dues, current	19,631	Publications	9,955
Annual dues, past	323	Postage and express	1,190
" " advance	109	Library	201
Paper sales	2,842	Salaries	4,322
Binding	151	Office expenses	606
Badges	807	Engraving	1,352
Engraving	324	Contingencies	92
Rent of hall and parlor	465	Binding	2,107
Life membership, bonds	3,900	Meetings	658
Life membership, cash	1,050	Furniture, etc	262
Profit and loss	7	Badges and certifs	1,161
Gift, bonds	500	Traveling	246
Postage and express	38	Rent	2,867
Interest	166	Work of committees	178
Balance on hand Nov. 1, 1891	2	Bonds bought	800
		Life membership bonds	3,900
		Gift of bonds	500
		Interest	185
		Cataloguing	25
		Insurance and safe deposits	17
		Balance on hand Nov. 1, 1892	1,628
Total receipts	$34,195	Total	$34,195

In explanation and comment on the above the committee beg to call attention to the fact that when the last report was presented in November, 1891, the dues were $10 per annum for members and associates, and $5 per annum for juniors. At the beginning of the fiscal year closing the dues were increased by $5 per annum for all grades. At the presentation of that report, there were outstanding bills against the Society amounting to $3,586.15, for which there was no money available, as the balance in the treasurer's hands had been drawn down to $2. The total receipts last year were $19,843; the total of this year's receipts, $34,193, shows an increase of over 73%.

As will appear from the report, not only has the entire back indebtedness been obliterated by the receipts of the year, but the committee have been able to meet the special charges for the re-issue of Volumes I., II. and III. of the Society's "Transactions," which had been exhausted in the earlier edition, which was small and was printed from type only.

Withdrawing from the summary the two items for printing and binding amounting to $3,538.23, which will not occur again, chargeable to this expenditure alone, the financial improvement is made still more apparent, inasmuch as the new edition is printed from plates which are the property of the Society, and constitute an investment from which it may realize in future sales of these volumes. The receipts from sales of publications are greater this year than usual, by reason of the sale of many copies to members who had subscribed for them.

The receipts from life membership account, $4,950, are larger than usual this year by reason of the policy, which is very generous in its relation to the society, which has been pursued by a number of members. They have constituted themselves life members by the payment of the $200 necessary for this purpose, using as a legal tender bonds to that amount, of those which were issued for the purchase of the house and lot which the Society occupies. By this means $3,900 worth of these bonds have been acquired, the principal of which surrendered bonds becomes the property of the Society; and as the bonds bear interest, they form a 5% investment during their period, and transfer the second mortgage lien to a greater extent from individuals to the organization. From the surplus the committee have also purchased bonds to the extent of $800, making a total of interest-bearing bonds now in possession of the council as trustees, which have been acquired through this and other means to the amount of $5,700, all of which is interest bearing, save a few bonds, the interest on which is by the deed of gift to be paid to the Library Association.

There is also deposited in savings banks to the credit of the Society, a fund of $2,358.97 bearing interest, and to be devoted to the purchase of books for the library. It will also be seen that this year the Society has made a comparatively small cash outlay for books, but has acquired over $200 worth of books by exchange for sets of its Transactions, as reported from the special library committee.

There remains outstanding uncollected dues for the year just closed to the amount of $1,396 from 80 members. This unusually small percentage in a membership of over 1,500 is generally considered phenomenal, and is doubtless due to the fact that the council have considered the annual dues to be a business and commercial obligation, and have directed that when it remains unpaid and overdue for 11 mos., the neglectful member shall be drawn upon at sight. This procedure, so usual in commercial circles, is doubtless the reason why so few remain in arrears, since no one is so by oversight, and only those who by reason of ill health or other good cause have requested an extension are those whose accounts remain open.

It speaks well for the healthy interest of all its active members in the Society that this state of affairs can be reported.

The report of the Library and the House Committee showed that the receipts from rentals to members of the rooms on the third and fourth floor had proved a very popular feature, and had resulted in a revenue of $1,646 during the year, all of which was credited to the Library Association, as also $3,670 received from rentals of parts of the building to the Electrical Engineers or for temporary use. The total revenue of the Library Association, including a gift of $600, was $6,927, of which $3,000 was paid out for interest, $2,238 in maintenance and improvement of the building, and $1,194 expended in library.

Mr. Jesse M. Smith then gave a verbal report in regard to the engineering headquarters at Chicago, which are to be on Van Buren St., between Michigan and Wabash Aves., about a block from the Auditorium and from the new Art Palace on the lake front, where the technical proceedings of the various congresses are to be held.

The following officers were found unanimously elected, barring a few scattering votes: President, Eckley B. Coxe; Vice-Presidents, C. W. Hunt, Thos. R. Pickering and Edwin Reynolds; Treasurer, Wm. H. Wiley; Managers, Chas. H. Manning, John Thomson, C. W. Pusey.

The Committee on Standard Pipe Flanges submitted several voluminous tables showing details of the practice of 25 manufacturers, and also submitted tentatively, for discussion only, a set of proposed standard dimensions for pipes from 2 ins. to 48 ins., which can doubtless be obtained by those interested from the secretary of the Society. We do not reprint it as it is likely to be very considerably amended before it is finally recommended, if it ever is. The committee comment on the voluminous material collected by it as follows:

The large diversity of dimensions of all sorts which is evident, is due, doubtless, to the individual growth of each concern, which has from time to time made only what its own requirements and experience seemed desirable, and with these divergencies to face it is evident that the problem presents some difficulties. While the dimensions given by manufacturers of cast iron pipe are comparatively small, the gates and valves which are to be used in connection with them are universally considerably heavier, which suggests the enquiry, why the slight additional thicknesses necessary may not be made by pipe manufacturers. The cost of molding would be the same, and the only apparent increase in cost of product would be the very few pounds of additional metal necessary and a trifling addition in the expense of facing; for in the latter case most of the time expended is in adjusting and centering the work in the lathes.

Another difficulty to be met was to harmonize the measurements of flanges used in conjunction with wrought iron pipe with those of gates and water mains. They have been generally made larger than cast iron pipe sizes, owing, first, to a reinforcing fillet encircling the pipe above the flange, and, second, to an increased diameter due to the necessity for a reasonable width of gasket outside of the inner flange face, where the metal is cut out for wrought iron pipe insertion.

If, after further consultation with manufacturers, it appears that they would be willing to slightly increase the dimensions of most of the flanges now made, the difficulty caused by the fillet can be avoided by making all flanges at their inner faces, except the smallest sizes, of sufficient thickness to insure the proper depth of pipe thread. For lower pressures, where a lesser thickness of metal will serve, a reduction may be made on the general surface, leaving the center around the pipe of the standard thickness; bosses for the bolts being kept at the same level.

If this method of construction is adopted it would appear to have the conspicuous advantage of reducing both the measurements of the bolt circles and the flanges, for the distance between the nuts and outside of the wrought iron pipe surface may evidently be reduced by the thickness of the reinforcement formerly used and the fillet at its base.

Scales for two pressures are proposed for sizes of 24-in. and over, as it was evident that from this size up that the discrepancies in measurements, both in pipe thickness and flanges, begins to be so great that two standards would seem advisable; one for pressures ranging up to 80 lbs. and the other to 200 lbs.

The thinner scale might perhaps be carried below 24 ins., but the objection to doing so is that at this point the difference in sizes is not very large, and as many of the builders of pumping engines use considerable quantities of pipe ranging from 18 ins. to 24 ins., a small difference in the dimensions of the two scales might lead to confusion.

The Committee on Standards (to advocate a bill before Congress to establish an office for receiving, recording and authenticating standards which might be adopted by reputable technical societies) reported in effect through its chairman, Jas. W. See, that the time was not ripe for it now, and it was doubtful if it ever would be, and requested its discharge, which was granted.

A long and interesting discussion on standard wire and plate gages then followed, precipitated by a report from an informal committee (Messrs. Eggleston and Wheeler) who had been asked to consider and report upon the expediency of a request to give the society's endorsement to a proposed new U. S. standard gage for iron and steel sheets. The gage began with the usual 0000000, and thence down to 0.1 and 38, varying irregularly by vulgar fractions of an inch. The sentiment of the committee and the society was strongly adverse thereto, and instead of that a resolution of the Society was passed looking toward a formal indorsement of a gage varying by thousandths of an inch for every kind of wire or plates of either metal or other material, "No. 1" meaning 0.001 in. thick; "No. 19," 0.019 in. thick; "No. 250," ¼ in. thick, "No. 1,250," 1¼ in. thick; etc. The sentiment of the meeting was unanimous in favor of such a gage as a substitute for all others, and except for the importance of the action a resolution adopting it, would have been passed there and then. As it is a committee is to be appointed and report.

At the session on Thursday morning a paper on bending strains in the rims of fly-wheels due to the stretching of the rim from centrifugal force was the first presented. We reprint it elsewhere. Mr. F. M. Rites, of the Westinghouse Machine Co., then presented a paper discussing the mathematics of the shaft governor. The author showed the distinction between "degree of regulation" and "rapidity of regulation," defining the former as "the percentage of variation of speed necessary to maintain an equality between the centripetal and centrifugal forces in governor adjustments." The rapidity of regulation is the speed of adjustment to the varying conditions of load or steam pressure. Due attention to both these requirements is necessary to a perfect governor. The practical result of the author's analysis was shown by the statement at the close of his paper that an engine of 500 HP. and making 220 revs. per min., was fitted with a governor designed in accordance with this analysis; the difference between no load and full load was found to be not more than one revolution. The paper was briefly discussed by Mr. Frank H. Ball, of the Ball & Wood Engine Co., who called attention to the fact that angular inertia or the inertia of the rotating weight about its own center of gravity had been generally overlooked in discussions on this subject. He believed, however, that there was rather less inertia among the designers of shaft governors than the author supposed.

Following this came a paper by Mr. W. A. Gabriel, of the Elgin Watch Co., on a new process of cutting cams. He has devised a machine for cutting cams more accurately and cheaply than can be produced by the cut-

and-try methods ordinarily used. The cutting tool is guided in its work by a lever resting on a revolving former made the shape of the cam to be cut and say five times its size. Thus any errors in the former are reduced to one-fifth their amount in the completed cam. Besides the machine for cutting ordinary cams, the author has devised machines for cutting a groove in the end or face of a cam and on the circumference of a cylinder. Two machines designed in the manner described by the author have been at work for three years at the Elgin Works with entire satisfaction.

A paper describing some work done on the design of a calculating machine was read by Mr. Geo. Richmond, of the De La Vergne Refrigerating Co. The author disclaimed any intention to produce any such wonder of mechanism as the difference engines of Babbage or Scheutz, and had not indeed carried the work of designing his machine to completion. His machine might fairly be called a calculating typewriter, and might be adapted for a variety of uses according to the degree to which its complication was carried.

Mr. G. W. Bissell, professor in the Iowa State Agricultural College, read a paper on the strains in lathe beds. His experiments showed that very considerable variations in the accuracy of lathe work might be caused by strains in the beds when made of the ordinary form. The author omitted to state the practical lessons which his experiments pointed out, but Past President Oberlin Smith did that for him in a masterly manner. He said that there were two ways of building machine tools; they could be built on the anvil principle or on the fiddle principle. The latter is the common method, but the former is the one which conduces to large output, accurate work and long life. He would make a lathe bed solid all the way through. The extra weight of cast iron costs very little compared with the steadiness and stiffness gained in the tool. All our machine tools are far too light in their stationary parts. As showing the economy of heavy tools he instanced a shop equipment of automatic screw-cutting machines, which was changed twice throughout, a lot of 700-lb. machines being thrown out for 1,500-lb. machines and these in turn giving way to 3,000-lb. machines. In conclusion he approved the three point principle of support, with suitable provision for stability. Mr. W. S. Rogers said the objection to extra weight in machine tools was the cost of freight, cartage and erecting, the difficulty of moving, and the weight on the floors, where machinery was placed on upper stories.

A paper by Mr. Samuel Webber, describing tests of driving belts was then presented. The tests were made on a double leather belt, plain, waterproofed and slotted, on two styles of leather link belts, on a perforated leather belt and on a leather lined canvas belt. There was less slip, and what occurred was more uniform with the slotted and perforated belts than with the solid belts. The link belts were so heavy that they heated the shaft of the friction pulley notwithstanding its thorough lubrication. The leather-lined canvas belt gave excellent results, but is difficult to lace and make a joint of proper strength. The slotted leather belt when so dressed as to be perfectly supple gave nearly as high results as the canvas belt.

Prof. W. F. Durand, of the Cornell School of Marine Architecture then read a paper on "The Limit of Propeller Efficiency as Dependent on the Surface Form of the Propeller." It was a mathematical discussion, and showed that the limiting efficiency of propellers in general depends not only on the theoretical efficiency of the helicoidal surface, but in the distribution of work over the surface, which does not admit of general analytical treatment.

The last paper at the morning session was by Mr. Geo. Richmond, discussing the thermodynamics of the refrigeration process.

Thursday evening's session opened with two mathematical papers by Prof. De Volson Wood, of Stevens' Institute, the first, an exhaustive investigation of hydraulic reaction motors, and the second an explanation of the term, "negative specific heat."

Then followed what was the most entertaining paper and discussion of the meeting, that of Mr. H. F. J. Porter, Assistant Mechanical Engineer of the World's Columbian Exposition, on the topic "How Can the Present Status of the Engineering Profession Be Improved?" The gist of the author's argument was that the standing of the profession with the public is seriously injured by the fact that anyone who chooses can assume the title or degree of an engineer. The blunders and rascality of those who assume the title with neither ability nor character causes people to look with distrust upon the work of all engineers. To remedy this state of affairs Mr. Potter proposed that the profession should undertake the task of deciding who may and who may not assume the title engineer. He suggested a classification of the whole engineering field into the following nine divisions: Mining, metallurgical, manufacturing, static, dynamic, land, hydraulic, aerial, military. An engineer would be required to obtain a license or testimonial of proficiency from a "Board of Regents" prior to practice in each of these departments. Standard fees should be agreed on, and thus "the large body of licensed specialists would be able to obtain a living, while the incompetent could not thrive." Mr. Porter suggested that the engineering congress at the Columbian Exposition might, with propriety, consider this subject, and wound up by saying that his remarks were simply offered to induce discussion.

So far as this object was concerned he was highly successful. Prof. R. H. Thurston opened with an admirable paper in which he expressed the view that the steady improvement in the technical schools was a chief and important agency in raising the standards of the profession. He urged that men unfitted by temperament or lack of natural abilities for the duties of the profession should be kept from entering it, so far as possible; that the technical schools should constantly strive to raise their standards of admission, and have their pupils well equipped with a good general education before starting them on their technical course. As President Gates, of Amherst, says: "It is better for a man to be a success in his profession at 30 than to enter it at 20." Finally, he called attention to the importance of specialization in professional work; and said that personal character was the final touchstone by which the standing of all members of the profession would be determined.

Mr. J. T. Hawkins suggested that the engineering profession be classified in two divisions, the "hypothetical" and "creative." Such investigators as Rankine and Hirn would go in the first class, while Watt, Corliss and Edison would occupy the second. Where the ordinary engineer would come in under such a classification he did not state. A further suggestion of his was that the inventive faculty was not sufficiently trained at the present time, and that a chair of invention ought to be endowed in every engineering college. The youthful inventors and "born mechanics" should be searched out and placed under its tuition.

So the discussion continued, a dozen or more members taking part in it. The original topic was soon lost sight of, and a brisk little controversy was started over the merits and demerits of the technical school graduate.

None of the "practical" men were disposed to deny that the engineers of the future would be graduates of technical schools; but they were able to tell some very good stories concerning the childlike ignorance of practical matters and the decidedly stupid blunders of certain technical graduates. The technical graduates were well represented in the meeting, however, and proved well able to sustain their end of the discussion, which was continued until nearly 11 p. m.

The concluding session of the meeting opened at 10 a. m., on Friday. Prof. D. S. Jacobus read his paper on experimental determination of the heat generated per candle-power in oil and gas lamps used for car lighting. He found that oil lamps produced about 191 British thermal units of heat per candle-power, and oil gas lamps (four-flame, Pintsch burners) about 127 B. T. U., showing that the oil gas is a considerably more efficient illuminant than the mineral seal oil.

Mr. R. Van A. Norris read a brief paper describing tests on a pair of duplex steam pumps which received their suction water under a piezometric head of about 60 ft. An air chamber was placed on the suction pipe and no trouble whatever was experienced in the working of the pump.

A rather interesting discussion followed, in which the fact was brought out that a great many "practical" engineers will not allow a pump to take its suction water under pressure. Nobody offered any reason for this expensive superstition, and the opportunity was not lost by the technical graduates to get a rap back at the "practical" man.

Prof. W. H. Bristol then exhibited his pressure recording gage for very low pressures, illustrated and described in another column; and was heartily applauded for his ingenious and interesting work.

Mr. H. C. Spaulding, of Exeter, N. H., presented a description of a variable speed power transmitting device. It consists of a pulley with a deep groove having inclined sides. By narrowing or widening this groove the belt is made to run farther from or nearer to the center and thus the leverage of the pulley is altered. The device is the invention of Mr. E. F. Gordon, Mechanical Engineer of the John A. White Co., of Dover, N. H. It has been applied to a band sawing machine the belt of which transmits about 10 HP. with satisfactory results.

Prof. R. C. Carpenter's description of an engine test made for the purpose of ascertaining the relative economy of simple and compound engines with a variable load was then presented. He found that the compound engine gave a higher economy with extreme variation of load than the simple engine, and that the effect of the steam jacket was to increase the economy from 2.75 to 5%. In discussion Professor Thurston called special attention to the fact that the jacket on the h. p. cylinder was proved to be nearly useless, because the difference of interior and exterior temperatures was insufficient to force much heat through the cylinder walls. Further, jacketing the barrel is the least effective method, and jacketing the heads is the most effective. While the gain by jacketing is not great, Professor Thurston said that its first cost was so small that it was a highly paying investment. For example, a jacket adding $10 to an engine's first cost might save $60 worth of coal per annum. Mr. W. C. Kerr, of the firm of Westinghouse, Church, Kerr & Co., pointed out that Professor Carpenter's tests had only showed that the compound engine had a high economy with a variable load when it was run condensing. He had not subjected it to variable load when run non-condensing, which is the way in which nine-tenths of the compound engines have to run.

Mr. Anthony Victorin read a paper describing tests made on the 120-ton bridge crane at the Watervliet Arsenal. The results showed that the efficiency varied from 22% to 67%. No mention was made, however, of the fact that the value of a crane depends on other considerations far more than on its actual economy in the use of power.

A new steam radiator arranged to graduate its radiating surface by filling up with water to various heights was described by J. T. Hawkins. The discussion brought out the fact that the same thing could be accomplished in a number of different ways and that commercial considerations would determine the importance of the invention.

Prof. C. H. Peabody's description of tests made on the triple-expansion engine at the Massachusetts Institute of Technology was then read. The conclusions reached from these tests were that it was quite possible to supply too much heat in steam jacketing; and that it makes little difference where the heat is supplied (to what cylinder) so long as enough and not too much is furnished. These statements were criticised by Mr. G. W. Rockwood and by Professor Thurston, the latter maintaining that it made a large difference where the jacket was applied.

The session closed with two very interesting topical discussions, one by Professor Sweet, on the weaving shed type of construction for a machine shop, the other by Mr. W. S. Rogers, giving some comparative tests of the milling machine and the planer, in which the milling machine was found to do six to nine times as much work as the planer in the same time.

COLUMBIAN ENGINEERING SOCIETY.—At a special meeting on Nov. 29, at the Columbian University Building, Washington, D. C., a paper on "The Evolution of Railways, with special Reference to Electricity as a Motive Force," was presented by J. Luttrell Murphy, Gen. Man. of the Robertson Electric Railway Co. E. C. Ruebsam, Secy.

NEW ENGLAND WATER-WORKS ASSOCIATION.—The regular quarterly meeting will be held at Young's Hotel, Boston, Mass., Dec. 14. In the morning the party will visit the recently completed covered reservoir at the Brookline water-works; and will also visit the Fisher Hill and Chestnut Hill reservoirs of the Boston water supply system, and the pumping station at the latter reservoir. Lunch will be served at 1 p. m. In the afternoon a description of the Boston water-works, illustrated by lantern slides, will be given by Desmond Fitzgerald, Resident Engineer of the additional water supply, and Superintendent of the Western Division of these works. A paper on "The New London Water-Works," will be presented by Walter H. Richards, Superintendent of the Works.

Secy., R. C. P. Coggeshall.

ENGINEERS' CLUB OF ST. LOUIS.—At the meeting on Nov. 16, President Johnson in the chair, 21 members and two visitors present, a paper on "Graphical Representation of the Output and Efficiency of Operation of a Dynamo" was read by Prof. F. E. Nipher, who stated that all of the quantities involved can be represented in terms of total E. M. F. magnetizing current and speed. The equation first published by Frolich represents the relation between these quantities in a very satisfactory way in a dynamo, which will run with brushes at a practically constant lead. This equation is the equation of an hyperbolic paraboloid, upon which lines of constant output, and constant efficiency, and constant torque can be drawn.

CORNELL ASSOCIATION OF CIVIL ENGINEERING.—At a meeting held Nov. 15, at Ithaca, N. Y., for reorganizing for the present year's work, the following were elected officers: President, Henry R. Lordly; Vice-President, Dan. B. Clark; Secretary, C. W. Ashby; Treasurer, John W. Ripley. The alumni, seniors and juniors of the College of Civil Engineering, constitute the membership roll, the officers being elected from the senior class. The object of the association is, primarily, to take up and discuss papers either sent in by members as the result of their individual efforts, or selected from the different periodicals published in the interest of the profession, and secondly, for the purpose of providing a course of lectures by non-resident lecturers the need of which is greatly felt at present.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.—At the regular meeting at Pittsburg on Nov.

15 the Committee on "Smoke" presented its final report, which was discussed fully. The committee covered the ground reported by its members, who were subdivided as follows: 1, General Chemistry and Physical Laws Governing Combustion; John W. Langley and Alfred E. Hunt. 2, Methods and Devices to Prevent Smoke; W. Lucien Scaife, D. Ashworth and C. Hyde. 3, Historical and Legal Methods Employed, and Present Consumption of Fuel in Allegheny County; Thos. H. Johnson, Alex Dempster and Thos H. Roberts.

At the meeting of the Chemical Section on Nov. 22, Mr. S. A. Ford, late chemist of Edgar-Thomson Steel Works, described his multiple filtering apparatus, and exhibited the machine. Mr. Weed described a satisfactory method of mounting mineral specimens, and a way of coating laboratory labels so that they would resist moisture and acid fumes. The Secretary read a paper by Fredk. H. Williams, chemist of the Riverside Iron Works, on "The Use of Hot Hydrochloric Acid in the Determination of Sulphur in Pig Iron by Evolution."

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—The next meeting will take place at the Kimball House, Atlanta, Ga., Jan. 19. The subjects for discussion will be as follows: 1, "The Best Course to Pursue to Reduce Oil Consumption in Engines and Cars," T. W. Gentry, A. T. Hooker and Jas. Cullen, special committee; 2, "Driving Boxes—Best Material and Shape in Order to Prevent Breakage and Wear; Is the Solid Box Suitable for Heavy Engines?" A. W. Gibbs, Jas. Meehan and F. E. C. Davis, special committee; 3, "Staybolt Inspection," R. P. C. Sanderson, W. H. Owens and F. H. McGee, special committee; 4, "Best Material for Piston Rods and Mode of Fastening Rod to Cross-Head and Piston-Head," G. W. O'Brien, Geo. D. Harris and Wm. Rutherford, special committee; 5, "The Experience of Members with Compound Engines." The following committee is expected to make a report: W. H. Thomas and Pulaski Leeds, on "Repair Work on Large Systems, and Location of Plants for Same." S. A. Charpiot, Secy.

UTAH POLYTECHNIC SOCIETY.—At the November meeting of the society, at Salt Lake City, the principal paper was by Admiral Selwyn, of the British navy, on the "Relations Between Solid, Liquid and Fluid Fuels," in which he showed how, to a very great degree the smoke nuisance can be eliminated with a great saving of fuel.

The topic of "Utah Building Materials and Their Application in Construction," was entered upon by Colonel Stevenson, the President, who brought to the attention of the society specimens of marble and onyx, and showed that they were of very great value for ornamentation and all interior decorations. Professor Cedarstrom gave a statement of his efforts to develop his quarries, and the results at the present time. Excellent specimens were shown by the Provo Sawing & Polishing Works. The constructive value of the Utah asphalts brought out from Captain Whitall, U. S. A., some statements of his experience in connection with hydrocarbons. He had recently returned from eastern Utah, and displayed several specimens of classified and unclassified bitumen, asphalts and mineral wax. Mr. James Parks, of New York, General Manager of the Cosmos Company, operating most extensively in southern and eastern Utah, referred to the asphaltic deposits of his company, and stated that the asphalts of Utah are constantly increasing in value in the eastern markets. Mr. H. L. A. Culmer confirmed the statement made by Mr. Parks that the asphalts of Utah of certain grades were every day becoming more and more valuable for painting and japaning purposes, and that they are now being used for these purposes almost to the entire exclusion of foreign material, and that his company is shipping from 50,000 to 100,000 lbs. per week to eastern and western points.

Colonel Stevenson then read a short paper on "The Better Maintenance of Street Pavements." He stated that foreign and home practice where asphalt pavements are being laid necessitated an increased width of tire of heavier vehicles, to lessen the wear on pavement and insure greater ease of traction. With this paper was presented a table by Mr. W. P. Hardesty, civil engineer, Salt Lake City, showing measurements made of our heaviest drays and of omnibuses and other large vehicles, demonstrating the fact that the widest tires in use for the heavier class of drays here are only 2½ ins., with weights occasionally as heavy as 1½ tons per wheel. For this weight the English and European legal requirements exact a width of not less than 6 ins.

"The Utility of Foliage on City Streets" was next discussed, bringing out a diversity of opinion, but showing that cities such as Worcester, Mas., New Haven, and Hartford, Conn., and Savannah, Ga., have found that foliage on the business streets had proved beneficial, and made the cities attractive in every sense of the word. Lieut. Salisbury, of the Weather Bureau, gave some interesting statements in support of an increase of foliage.

LIVERPOOL ENGINEERING SOCIETY.—The second ordinary meeting of the session was held Nov. 9, Mr. Robert E. Johnston, President, in the chair, when a paper entitled "The Development of the Machinery of Atlantic Liners" was read by Mr. A. J. Maginnis. He commenced by pointing out the gradual development in the horse-power, displacement and speed of various representative vessels from the "Savannah" in 1819 to the coming Cunard steamer "Campania," which was estimated to represent 20,000 tons displacement, propelled 22 knots with 1.5 I. HP. to the displacement ton. Commencing with side lever engines for paddle-wheel vessels, the various types of machinery of this class were described, followed by descriptions of screw propelling machinery, in the various forms of beam, steeple, oscillating and other geared screw engines, also various types of direct acting engines, and the evolution to compound and triple expansion engines. After a general description of the various classes of boilers, the important matter of the weight and thickness of boiler shells as at present constructed was noticed. The pressing need of improvement in the marine boiler is to reduce the weight and space occupied, and it was noticed, that of all the various forms used, marine engineers generally look to the locomotive boiler as coming nearest to meet their requirments in the future. With the improvements in the feed, and general working of boilers which have taken place, the author considered that the successful working of this class of boiler was now within measureable distance. The machinery of the more recent liners are commented upon, and their performance noted in comparison with the older and with the coming vessels. Several interesting tables were given showing the gradual development of the machinery now in use.

ENGINEERS' CLUB OF PHILADELPHIA.—Meeting of Nov. 19, Pres. James Christie in the chair. Thirty members and visitors present. The first business was the proposed revision of the constitution and by-laws. Most of the changes were in wording and arrangement, the few radical ones being as follows: The appointment of the Secretary by the Board of Directors instead of his election by the club. Making the number of votes necessary to reject a candidate for active membership 5% of the legal votes cast, and in the case of honorary members, 3% of the legal votes cast. Increasing the annual dues of resident members and associates to $15. Limiting the honorary membership to 1% of the active membership, and time for election of honorary members to the annual meeting. These matters were informally discussed by members present, and the draft of the revised constitution and by-laws will be presented at the next meeting on Dec. 3.

The discussion on the water supply of Philadelphia was continued. Mr. Edwin F. Smith confined his remarks mainly to the question as to whether or not the Schuylkill River is available, as to quantity and quality, to supply the needs of the city. It is now, and must continue to be for some time at least, its main supply, as the project for changing the source of supply would require years for its execution. While in 1867 the condition of the river at Philadelphia was in a worse state of pollution than it is now, and although the population of the city has increased enormously since then, the death rate, which is the surest indication of the condition of the water supply, has not increased, the reason being that much has been done, especially in the last ten years, to improve the supply by diverting well known sources of pollution within the city limits. It is questionable whether there has been any marked change in the minimum flow of the river in the past 50 years, assertions to the contrary notwithstanding. The figures reported by the Water Bureau for the year 1816 are based upon float measurements, but there is no means of knowing whether they represent the minimum flow (as has been stated) or not. The matter cannot be taken from a single measurement, but should be the minimum of the natural flow of the stream for 24 hours, selected after careful gaging, from observations extending over a long period of years. The minimum flow of 210,000,000 gallons (by weir measurement) was reached this year during a few days in the present month, the average daily flow during the season of drought being about 250,000,000 gallons.

When the recent drought was most severe, and the flow of the river at its minimum, a large part of the water used was for power at the Fairmount works, where turbine wheels are employed, and use not less than 20 gallons of water for power for 1 gallon pumped into the reservoirs. The quantity used for power at times amounted to over 100,000,000 gallons per day. With this quantity to spare in the natural flow of the stream in seasons of extreme drought, to say nothing of the 4,500,000,000 gallons stored in the dams of the river above Flat Rock, it cannot be said that the Schuylkill River is insufficient in quantity to supply the city's needs, and there is little fear of a water famine for many years to come.

With regard to the quality of the water, the statement that the Schuylkill at Philadelphia receives the sewage from a population in the Valley of over 400,000 people is certainly a gross exaggeration. It may have been made inadvertently, but it has also been constantly asserted in public journals that the sewage from a population of 250,000, with hundreds of large manufactories, drains directly into the river. There is no such population contiguous to the River Schuylkill and its tributaries, so near as to drain into it, and no reasonable person would contend that drainge from farms in the open country, away from all water courses, finds its way into the river. The total population of all towns in the valley is about 135,000, about one-half the usual estimate, and there is not a regularly sewered town, with the exception of Pottsville, in the valley. The towns from Norristown down remain a menace to the purity of the water supply, but they only pollute the stream to a small extent at present, as they are not yet sewered. For a long time to come it will be cheaper for the towns in the valley to keep sewage out of the river than it would be to go to distant sources of supply. The most dangerous sources of pollution for the Schuylkill River are within the city limits, less than five miles from its pumping stations. Considering all these facts it is worse than folly to condemn the Schuylkill in such a wholesale manner, and more especially to charge evils to it which have no certain existence.

Mr. John E. Codman: What Mr. Smith has said about the Schuylkill supply is in accordance with observations that have been made by the Water Bureau. In October of this year, the rainfall varied in Eastern Pennsylvania as follows: Philadelphia, .32 in.; Lebanon, .29 in.; Reading, .20 in.; Doylestown, .32 in.; Pottsville, .48 in.; Quakertown, .63 in., and Seisholtzville, .61 in. With the present storage capacity slightly increased, our future needs would be amply provided for, and if we could control the matter of sewage disposal, the Schuylkill River would be a very good source of supply. If a gravity supply could be obtained in sufficient quantity, it would, of course, be superior to one that had to be pumped. L. F. Rondinella, Secretary.

COMING TECHNICAL MEETINGS.

NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
Dec. 9, Secy., D. W. Meeker, St. Paul.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
Dec. 9, Secy., C. H. McLeod, Montreal, P. Q.
WISCONSIN POLYTECHNIC SOCIETY.
Dec. 12, Secy., M. F. Schinke, City Hall.
ENGINEERS' CLUB OF KANSAS CITY.
Dec. 12, Secy., Waterman Stone, Baird Building.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
Dec. 14, Wichita, Kan.
NEW ENGLAND RAILROAD CLUB.
Dec. 14, "High Speed for Trains," Secy., F. M. Curtis, O. C. R. R., Boston.
NEW ENGLAND WATER-WORKS ASSOCIATION.
Dec. 14, Young's Hotel, Boston, Mass. Secy., R. C. P. Coggeshall, New Bedford, Mass.
NEW YORK RAILROAD CLUB.
Dec. 15, Secy., H. G. Prout, 73 Broadway, N. Y.
ENGINEERS' CLUB OF CINCINNATI.
Dec. 15, Secy., J. F. Wilson, 24 W. 4th St.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
Dec. 15, Secy., C. F. Franson, Portland Block.
TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
Dec. 16, 201 Washington Building.
SWEDISH ENGINEERS' CLUB.
Dec. 17, Secy., P. Valentine, At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago; Secy., John Ericson.
ENGINEERS' CLUB OF PHILADELPHIA.
Dec. 17, 1122 Girard St. Secy., L. F. Rondinella.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Dec. 20, "Water Purification's." Secy., R. H. Clark, Pittsburg.
WESTERN RAILWAY CLUB.
Dec. 20, Rookery Building, Chicago, Secy., W. H. Marshal.
BOSTON SOCIETY OF CIVIL ENGINEERS.
Dec. 21, "Base Line Measurements with the Steel Tape," Prof. A. E. Burton. Secy., S. E. Tinkham, 36 Broomfield St.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Dec. 21, Secy., F. Collingwood, 127 East 23d St., New York.
ENGINEERS' CLUB OF ST. LOUIS.
Dec. 21. Secy., Arthur Thacher, Odd Fellows' Building.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Jan. 2, Secy., C. L. Annan, City Engineer's Office.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
Jan. 3. Secy., Chas. S. Howe, Case School.
ENGINEERS' SOCIETY OF PHŒNIXVILLE.
Jan. 3. Secy., W. Halliburton.
WESTERN SOCIETY OF ENGINEERS.
Jan. 4. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Jan. 6. Secy., E. K. Smoot, 906 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
Jan. 6. Secy., O. Von Geldern, 719 Market St., San Francisco.
NORTHWEST RAILROAD CLUB.
Jan. 7. Union Station, St. Paul.
MONTANA SOCIETY OF CIVIL ENGINEERS.
Jan. 7. Secy., F. D. Jones, Helena.
NORTHWESTERN SOCIETY OF ENGINEERS.
Jan. 10. Secy., D. W. McMorris, Burke Block, Seattle, Wash.
DENVER SOCIETY OF ENGINEERS AND ARCHITECTS.
Jan. 10, Secy., Geo. H. Angell, 35 Jacobson Block.
ATLANTA SOCIETY OF CIVIL ENGINEERS.
Jan. 10. Secy., Parker N. Black, Capitol Block.
ENGINEERS' CLUB OF MINNEAPOLIS.
Jan. 12. Secy., F. W. Cappelen, 1026 Hennepin Ave.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
Jan. 12. Secy., Edward Mead, Norton Building.
ENGINEERING ASSOCIATION OF THE SOUTH.
Jan. 12. Secy., O. H. Landreth, Nashville, Tenn.
MICHIGAN ENGINEERING SOCIETY.
Jan. 17, 18, 19. Annual meeting at Lansing, Mich. Secy F. Hodgman, Climax, Mich.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Jan. 19. Atlanta, Ga. Secy., F. A. Charpiot, Macon, Ga.
CENTRAL RAILWAY CLUB.
Jan. 25. S. W. Speer, E. Buffalo, N. Y., Iron Works.
AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 21, etc. Annual meeting, Montreal, Que. Secy., R. W. Raymond, 6 Burling Slip, New York, N. Y.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Published Weekly at Tribune Building, New York. Entered at the Post Office, New York City, as Second Class Matter.

VOL. XXVIII. THURSDAY, DECEMBER 8, 1892.

D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

SUBSCRIPTION RATES: One year, $5.00; 6 months, $2.50; 4 months, $2.00; single copies 15 cents. To all foreign countries in the Postal Union, add $2.08 to above prices for postage. Subscribers can have the mailing address of their paper changed as often as they desire. They should send both the old and the new addresses. No club rates are allowed.

The date when the subscription expires is on the address label on each paper, the change of which to a subsequent date becomes a receipt for remittance. No other receipt is sent unless requested.

ADVERTISING RATES: 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The interesting address of President Charles H. Loring, of the American Society of Mechinical Engineers, which is reprinted in full in another column bears just and eloquent testimony to the overwhelming importance of the steam engine as the creator and sustainer of modern civilization, and truly says that "we who are born under this benign influence but vaguely appreciate its value and rarely recognize our obligations to it"—to the full extent, at least. But in his admiration of this great agent of civilization Mr. Loring goes somewhat beyond the general view, at least, if not beyond the true view, by declaring in effect that the steam engine is not only the first but the last great word of science in this direction. He says early in the address:

> It was to the relief of all mankind that the immortal inventor of the steam engine gave to the world the finest solution of the problem (of power) it can ever hope to receive.

This judgment he repeats in effect at the end of his address where he answers the question: "Can the inventive mind of man bring into being any other device that will do its work cheaper, better and more handily?" To this he answers that "that already dreamed of is the limitation of our resource," thus excluding the possibilities of any material improvement of the steam engine which has not been already dreamed of, and goes on to enumerate as the remaining hopeful possibilities, better utilization of water, wind and tide power and possible direct conversion of heat into electricity, adding the opinion that even "when all shall be realized which these as yet unused resources offer to man, the steam engine will still remain the grandest conception of the human mind, the great conservator of the human race."

It may be that this view is correct, but it seems to us quite too sweeping. There is still a known possibility of doubling or tripling the economy of the steam engine itself and there is the possibility of converting heat energy into working energy direct, which the analogies of nature teach us can be accomplished simply somehow, because it is accomplished, but to which man has hardly yet begun to give serious attention, for the very good reason that he has only recently come into a position to do so. Who then can now declare or even rationally guess at man's ultimate powers in either of these directions, not to speak of other possible directions not yet suspected?

The danger of protecting crossings by gates during the day and then leaving them unprotected with gates up during the night was again illustrated by a distressing accident at Elmira, N. Y., Nov. 30, by which five persons lost their lives. Such a practice is rather worse than having no gates at all and should be forbidden by law, at least in cases of main lines like the Erie which have about as many trains by night as by day. Its obvious effect is to create a feeling of false security in the minds of the public in regard to that particular crossing. Traveling by day only, as most men do, the public gets to looking upon that particular crossing as only dangerous when the gates are down or going down. When the rare occasion comes for night travel the average man will assume as a matter of course, as he has a right to do, that gates up means safety by night as it does by day. This is especially so because the man traveling by night is apt to be out for pleasure rather than business, and particularly apt to be in a jovial and negligent state of mind, which is a lawful state of mind, and one in which every citizen has a right to be protected as fully by night as by day. The time cometh and now is when trunk lines like the Erie may properly be required to eliminate all grade crossings from its track, but until that is done, they should at least cease to set traps for the unwary by making the same condition of the gates mean safety by day and danger by night.

An expensive blunder in the arrangement of pumping plants which appears to be not uncommon, was discussed at the recent meeting of the American Society of Mechanical Engineers. It seems to a common idea that a pump must not have its suction side under any considerable pressure. In a case cited the water supply for the pumping station of a town water-works was piped to the pumping station under a head of about 60 ft. Instead of utilizing this head to assist the pumps, the pipe was allowed to empty into a receiving well at the pump station and the pump suction was taken from this well. The engineer who had the temerity to suggest that the supply main might be connected directly to the suction with a large decrease in the load on the pump had a hard fight to get his plan carried into effect. Other cases were reported where large sums were expended to make sumps and reservoirs for pumps to draw from and avoid placing any pressure on the suction side of the pump plunger. The only reason cited for this wasteful method of working is that the suction valves would not seat, were the suction under a head; but this is apparently pure theory. The real reason, probably, why a prejudice exists against pressure on the suction side of the pump is the water hammer which is apt to accompany it. This is easily obviated by placing an air chamber on the suction side, and indeed, this is a benefit to any pump where the suction main is of any considerable length. The necessity of an air chamber on the force main seems to be easily comprehended; but the advantages of a similar cushion on the suction main escape the attention of all but a very few. A large proportion of the troubles with water hammer in pumps could be obviated by a proper arrangement of air chambers. That placing an air cushion on the suction is far preferable in point of economy to the frequently practiced plan of snifting in air or even forcing it in by an air compressor will hardly be denied.

St. Louis is now having its turn at an epidemic of typhoid fever. In November, according to the "Globe-Democrat," 165 deaths from that disease were reported, which number is eight greater than the average of the total yearly number of typhoid deaths for the past 25 years. For the week ending Nov. 28, there were 35 typhoid deaths and for the week ending Dec. 3 there were 84 deaths. Nearly all of the cases are between Grand Ave. and the river, which is said to be the most completely sewered portion of the city and to be more generally supplied with river water than any other section. A local physician, according to press dispatches, has made a chemical analysis of the city water and states that organic matter is present in unusual quantities.

No satisfactory explanation of the cause of the epidemic has yet been proposed, some people attributing it to the water supply and others to the sewerage system, bad plumbing or rendering works up the river. Mr. Robert E. McMath, M. Am. Soc. C. E., is reported as hinting, though doubtless not believing much in such a possibility, that perhaps the water may be contaminated by the sewage of Chicago, which finally reaches the Mississippi River above St. Louis after a total journey of some 375 miles, and so might bring typhoid germs to St. Louis. As a comparison with the 165 typhoid deaths in St. Louis in November there were in the 13 weeks ending Nov. 19, only 156 deaths from typhoid in New York city. The population of St. Louis, by the last U. S. Census, was 451,775; that of New York, is now about 1,700,000.

With a rapid increase of typhoid fever throughout the month of November it does not appear that any adequate biological examinations of the water supply were made under the direction of the city authorities; or, if made, its results have not been made public to our knowledge. A city of the size of St. Louis, drawing water from a river always open to pollution, would do well to have weekly chemical and biological examinations of its water supply made by acknowledged authorities, which is perhaps aimed at by the recent establishment of a chemical laboratory in connection with the water-works, with Mr. John L. Wicksford as chemist in charge. Work has been in progress for several years on a new water supply from a source further up the river, which plainly is needed.

RAILWAY CONSTRUCTION IN THE FAR WESTERN STATES.

The statistics of railway construction in the far Western States, which accompany the last of our series of sectional maps of railway progress for 1892, show, as was to be expected, a general decrease in activity from last year's figures. The following is a summary of the work in progress in each state as shown by the detailed list of lines given elsewhere in this issue:

States.	—Track laid.— In year 1891.	To date in 1892.	In process of construction.	Located and under survey.	Projects of some promise.
Wyo.....	48	90	20	...	215
Mont.....	188	127	20	468	735
Idaho.....	20	83	31	438	255
Wash.....	141	396	273	140	140
Ore.....	65	12	...	498	17
Cal.....	144	80	...	308	*2,883
Nev.....	...	...	71	...	...
Utah.....	78	4	76	126	550
Colo.....	145	15	75	581	158
N. Mex....	18	6	20	200	843
Ariz.....	...	...	200	100	8
Total....	847	813	786	2,659	4,779

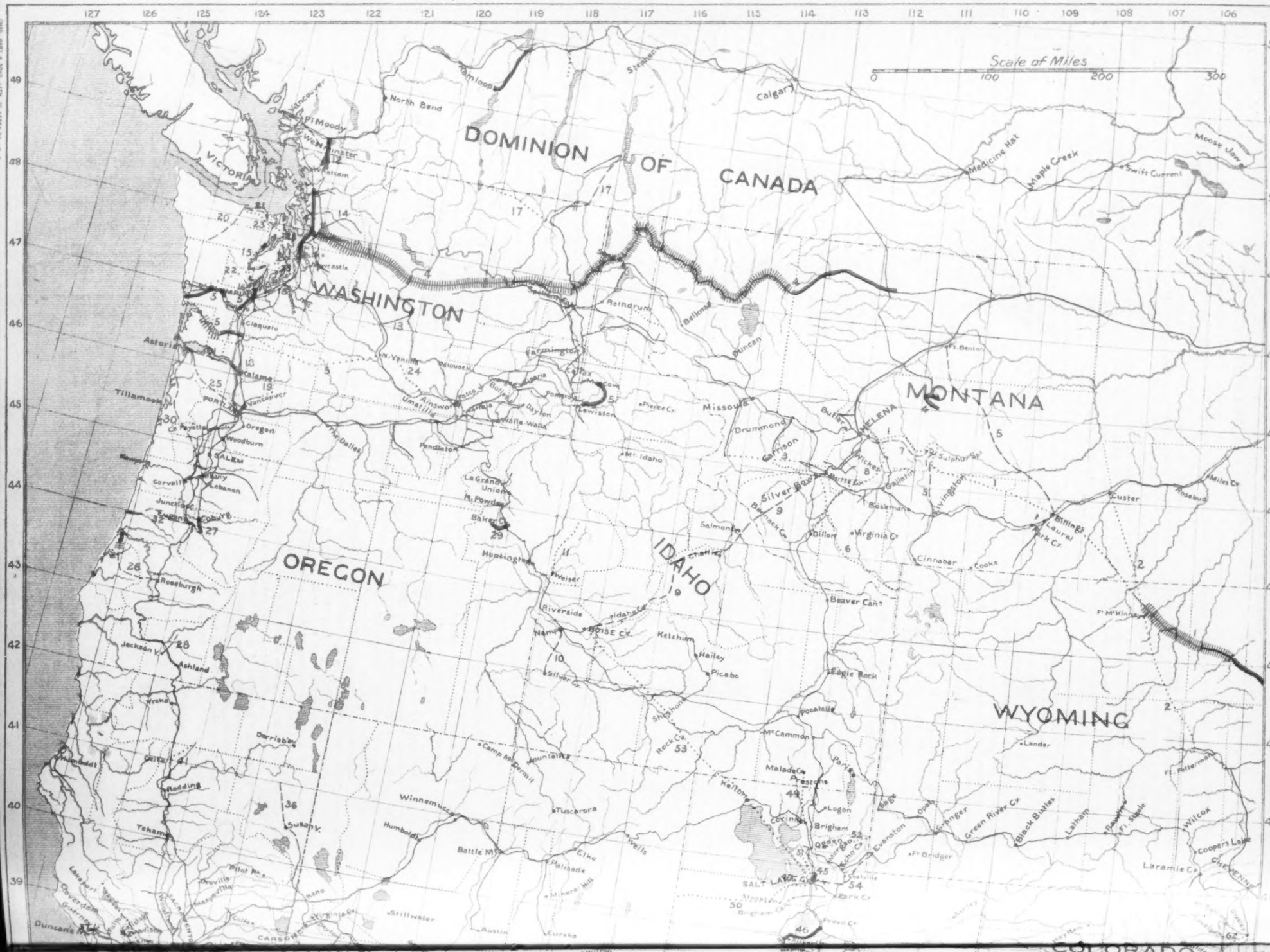
By comparing this table with that given in previous maps of this section it will be seen that there has been very little change in the position of the centers of most active construction. The States of Montana, Idaho, Washington and California comprise the greater part of the mileage of new railway completed this year and in process of survey and construction, as well as that projected with more or less prospect of being constructed in the future. A further examination of the detailed list shows that, as in 1890 and 1891, nearly all of the active work is being done by the large systems. In Montana, Idaho and Washington, the Great Northern and Northern Pacific are doing the greater part of the work; in California the Southern Pacific has the more valuable portions of the state covered by a system of lines in progress of construction and projected, and in Utah, Colorado and Arizona the Atchison, Topeka & Santa Fe, Denver & Rio Grande and Rio Grande Western are building most of the new lines. Of course there are a large number of new enterprises independent of any of the large systems. Some of these will undoubtedly be eventually built and operated as independent lines and a somewhat larger number will be taken up and carried to completion by old companies; the great, majority, however, will probably never advance beyond their present state of imperfect organization.

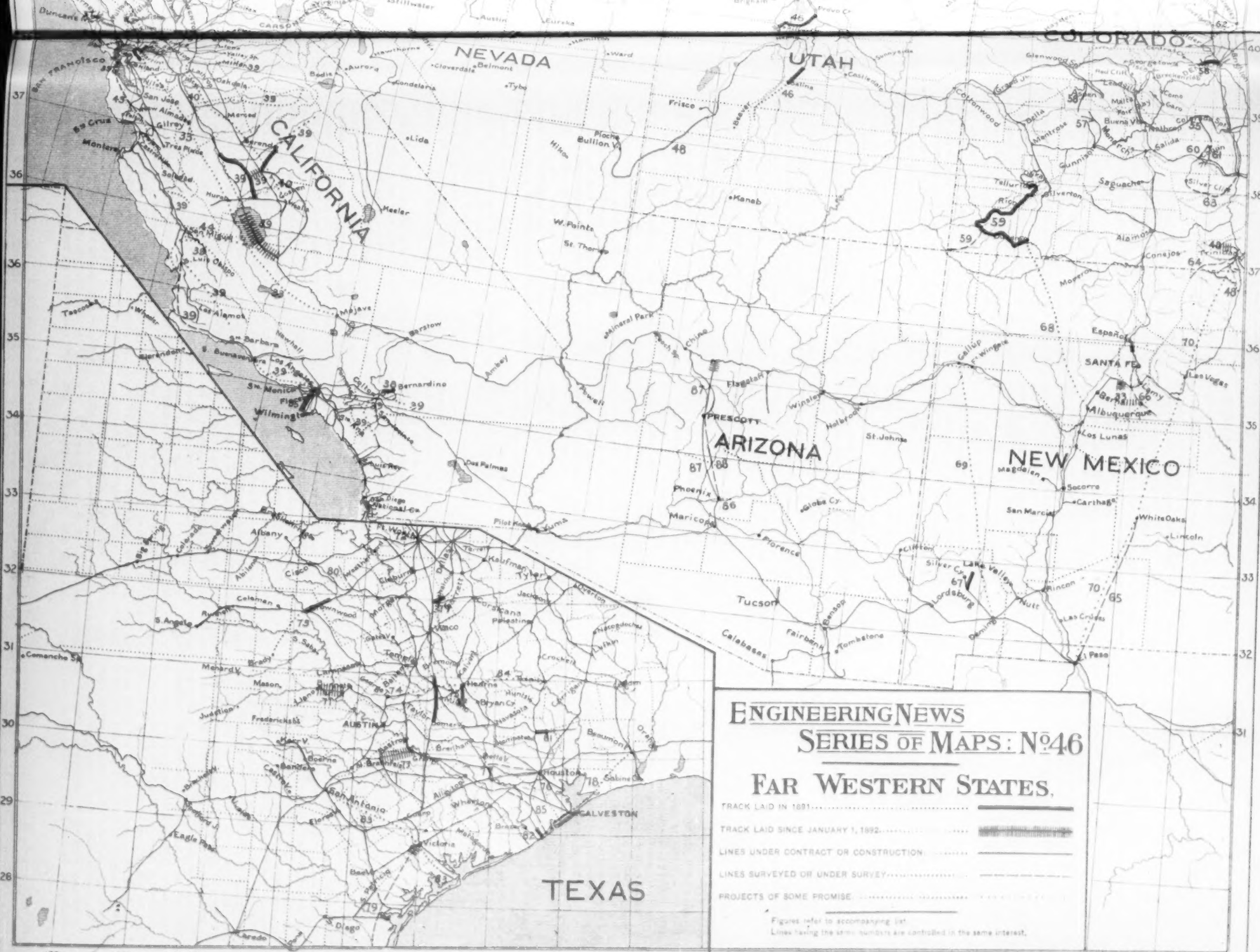
Comparing the totals given in the above table with those published in connection with the last preceding map of this section we have the following results:

	—Track laid— Year previous.	Portion of year to date.	Under construction.	Under survey.	Projected.
Nov. 28, 1891.....	1,303	883	1,079	4,130	5,875
Dec. 8, 1892.....	847	813	786	2,659	4,779
Dec., 1892.....	456	70	293	1,530	1,096
Dec. %.....	35	7.94	27	36.5	18.7

The decrease in new construction shown by this comparison varies from 7.94% in the mileage of

*1,430 miles of this not included in table. See detailed list.


Scale of Miles
0
100
200
300
DOMINION OF CANADA
WASHINGTON
OREGON
IDAHO
MONTANA
WYOMING
COLORADO
Vancouver
Moody
Westminster
Victoria
Nanaimo
Kamloops
Stephen
Calgary
Medicine Hat
Maple Creek
Swift Current
Moose Jaw
North Bend
Bellingham
Whatcom
Seattle
Tacoma
Olympia
Chehalis
Kalama
Vancouver
Portland
Astoria
Tillamook
Claquato
Oregon City
Woodburn
SALEM
Albany
Lebanon
Corvallis
Junction C.
Eugene
Coburg
Roseburg
Jacksonville
Ashland
Yreka
Redding
Delta
Dorris
Tehama
Susan V.
Winnemucca
Humboldt
Battle Mt.
Elko
Palisade
Wells
Pilot Pk.
Oroville
Stillwater
Virginia Cr.
Austin
Eureka
Carson
Duncan's Pass
Lassen Pk.
Shasta
Mt. Shasta
Ritzville
Spokane
Pullman
Lewiston
Pierce Cr.
Pomeroy
Dayton
Walla Walla
Pendleton
The Dalles
Umatilla
Ainsworth
Palouse
Farmington
Tekoa
Moscow
Rathdrum
Belknap
Duncan
Missoula
Drummond
Garrison
Butte
Helena
Ft. Benton
Buffalo
Whitehall
Sulphur Sp.
Gallatin
Bozeman
Livingston
Miles Cr.
Custer
Rosebud
Billings
Laurel
Park Cr.
Dillon
Virginia Cr.
Salmon
Beaverhead Co.
Silver Bow
Cinnabar
Cooke
Ft. McKinney
Beaver Can.
La Grande
Union
N. Powder
Baker C.
Huntington
Weiser
Riverside
Idaho C.
Boise C.
Nampa
Silver Cr.
Ketchum
Hailey
Picabo
Eagle Rock
Shoshone
Rock Cr.
Camp Ap. Summit
Darrisbee
Deltz
Malade Cr.
Preston
Pocatello
McCammon
Lander
Ft. Fetterman
Logan
Brigham
Ogden
Echo Cr.
Evanston
Coalville
Park Cr.
Provo Cr.
Fr. Bridger
Green River Cr.
Black Buttes
Latham
Rawlins
Ft. Steele
Wilcox
Coopers Lane
Cheyenne
Laramie Cr.
Corinne
Promontory
Stockton
Brigham Cr.
SALT LAKE C.
Ophir
Tintic
Juab
Nephi
Manti
Gunnison
Grand Junction
Green River
Thompson
Ouray
Lake City
Del Norte
Alamosa
Saguache
Gunnison
Salida
Pueblo
Colorado Springs
Denver
Cheyenne
Ft. Collins
Greeley
Boulder
Golden
Central City
Georgetown
Idaho Springs
Breckenridge
Leadville
Buena Vista
Granite
Twin Lakes
Aspen
Glenwood Springs
Rifle
Grand River
Parachute
Battlement Mesa
Plateau
Mesa
Debeque
Grand Valley
Fruita
Gateway
Uncompahgre
Ridgway
Ouray
Silverton
Lake City
Del Norte
Alamosa
Saguache
Gunnison
Salida
Pueblo
Colorado Springs
Denver
Cheyenne
Ft. Collins
Greeley
Boulder
Golden
Central City
Georgetown
Idaho Springs
Breckenridge
Leadville
Buena Vista
Granite
Twin Lakes
Aspen
Glenwood Springs
Rifle
Grand River
Parachute
Battlement Mesa
Plateau
Mesa
Debeque
Grand Valley
Fruita
Gateway
Uncompahgre
Ridgway
Ouray
Silverton


NEVADA
UTAH
COLORADO
CALIFORNIA
ARIZONA
NEW MEXICO
TEXAS
SANTA FE
PRESCOTT
Albuquerque
Tucson
El Paso
AUSTIN
GALVESTON
Los Angeles
San Francisco
San Diego
Phoenix
Denver
Salt Lake City
Reno
Las Vegas
Flagstaff
Tombstone
Fairbank
Benson
Lordsburg
Silver City
Deming
Las Cruces
Socorro
Carthage
Albuquerque
Los Lunas
Española
Lamy
Pueblo
Colorado Springs
Trinidad
Alamosa
Saguache
Gunnison
Montrose
Durango
Silverton
Telluride
Ouray
Grand Junction
Glenwood Springs
Leadville
Salida
Buena Vista
Canon City
Monte Vista
Conejos
Del Norte
Antonito
Chama
Farmington
Gallup
Fort Wingate
Holbrook
Winslow
Williams
Ash Fork
Seligman
Kingman
Needles
Barstow
Mojave
Bakersfield
Fresno
Merced
Stockton
Sacramento
Oakland
San Jose
Santa Cruz
Monterey
Salinas
Hollister
Gilroy
Los Gatos
Santa Clara
Redwood City
San Mateo
San Francisco
Oakland
Berkeley
Alameda
Hayward
San Leandro
Niles
Livermore
Tracy
Modesto
Turlock
Madera
Hanford
Visalia
Tulare
Lemoore
Corcoran
Delano
Bakersfield
Maricopa
Florence
Globe
Miami
Clifton
Morenci
Solomonville
Safford
Willcox
Benson
Tombstone
Fairbank
Nogales
Calabasas
Yuma
Parker
Blythe
Indio
Banning
San Bernardino
Colton
Riverside
Pomona
Los Angeles
Santa Monica
Long Beach
Wilmington
Santa Barbara
Ventura
Oxnard
Hueneme
San Luis Obispo
Guadalupe
Santa Maria
Lompoc
Surf
Gaviota
Goleta
Santa Barbara
Carpinteria
Ventura
Saticoy
Montalvo
Hueneme
Oxnard
Port Hueneme
Los Angeles
Pasadena
Monrovia
Azusa
Glendora
San Dimas
Pomona
Ontario
Cucamonga
Rialto
San Bernardino
Redlands
Highland
Mentone
Crafton
Loma Linda
Riverside
Arlington
Corona
Elsinore
Perris
San Jacinto
Hemet
Beaumont
Banning
Indio
Coachella
Mecca
Salton
Imperial
El Centro
Calexico
Brawley
Holtville
Calipatria
Niland
Westmorland
Salton Sea
Coachella Canal
All American Canal
Imperial Valley
Colorado River
Gila River
Salt River
Verde River
Little Colorado River
Grand Canyon
Painted Desert
Petrified Forest
Navajo Reservation
Hopi Reservation
Zuni Reservation
Jicarilla Reservation
Ute Reservation
Southern Ute Reservation
Ute Mountain Reservation
Mesa Verde
Rio Grande
Rio Grande Valley
Pecos River
Pecos Valley
Canadian River
Arkansas River
Platte River
South Platte
North Platte
Cheyenne
Laramie
Rawlins
Green River
Evanston
Ogden
Provo
Salt Lake City
Tooele
Wendover
Ely
Eureka
Austin
Battle Mountain
Winnemucca
Lovelock
Fernley
Reno
Carson City
Virginia City
Gold Hill
Silver City
Dayton
Wadsworth
Fallon
Hawthorne
Tonopah
Goldfield
Beatty
Las Vegas
Boulder City
Henderson
Searchlight
Needles
Barstow
Daggett
Yermo
Mojave
Tehachapi
Bakersfield
Fresno
Merced
Stockton
Sacramento
Oakland
San Francisco

track laid this year to 36½% in the mileage of line surveyed or under survey. There is little to say which will modify the results shown by the comparison. In general the figures considered alone indicate that less new line will be built in 1893 than will be built this year, and a general study of the situation seems to confirm this indication.

Taking up now the work of construction in individual states a few words of explanation in regard to some of the lines is necessary. The only line in Wyoming upon which any construction has been done is the extension of the Burlington & Missouri River R. R. This extension has been gradually pushed forward from a connection with the main line in Nebraska until it is now completed nearly to the Montana line. Its ultimate terminus has not been given out by the company but indications point to its being Helena, Mont., or some other point where connection can be made with the railway system of Montana.

In Montana the most important work of new construction is the Pacific extension of the Great Northern line which is now practically completed across Idaho and Washington to Puget Sound. Aside from this no construction of especial importance is in progress. The several surveyed lines and all of the projected lines are yet in a state of too great uncertainty to be worthy of much consideration. In Idaho and Washington, as in Montana, the Great Northern extension is by far the most important portion of the new construction for 1892. In Washington, however, general construction is more active than in either of the other states, and, in fact, than in any of the other states covered by our map. A very large proportion of this is in the vicinity of the Puget Sound. The most noteworthy of these lines which will probably be carried through within the next year or two are the Everett & Monte Christo and the Portland & Puget Sound. The former of these starts from a point on Puget Sound and penetrates the Cascade Mts. to the Monte Christo mining region. The construction on this line is unusually heavy. The Portland & Puget Sound line was surveyed and partly graded in 1890 but work was discontinued upon the change of management of the Union Pacific Ry. Co., which, jointly with the Great Northern, was building the line. The prospects are that, now that the Great Northern has completed its extension to the coast, work will be resumed. In fact surveys have already been begun toward this end. The work includes a long bridge across the Columbia River at Portland, considerable work upon the foundations of which has already been done.

Passing south into Oregon it will be seen that most of the work is, in the western portion of the state. Among the more important of these lines are: the Astoria & Portland R. R., the Albany & Astoria R. R. and the Coos Bay, Roseburg & Eastern R. R. The location and lengths of these three lines are given on the map and in the accompanying list.

The most noticeable thing in the work under way in California is the very large mileage of projected lines. The recent reincorporation of the Southern Pacific R. R. Co., in that state provided for the construction of a considerable number of new lines and the most important of these have been included on the map. It should not be understood from this, however, that the construction of these lines will be undertaken at once. They will be built as soon as the growth of the traffic will seem to warrant them but no sooner. In addition to these a large amount of talk has been done toward securing a competing line to the East, and several companies have been organized for this purpose. Three of these are given in the detailed list. It will be seen that two of these run from the Bay of San Francisco south to various points in the San Joaquin Valley, probably with the intention of connecting with the Atchison system and thus securing an outlet east. The more important of the three, however, is that projected from San Francisco to Salt Lake City, Utah. This enterprise is being financiered by a number of the principal business men of San Francisco and will compete directly with the Central Pacific. A more or less complete survey was made this summer from San Francisco east to the Nevada line, but at this point work was discontinued for the winter. The promoters confidently assert that the surveys will be continued and the line built, but considering its great cost, the probabilities of paying traffic, and the opposition which its construction will meet, this is not so certain. Moreover, it seems entirely likely that the Atchison system may conclude to build its long projected extension to San Francisco before long.

In the remaining five states and territories there are but a few lines worthy of especial mention. The Santa Fe, Prescott & Phoenix, in Arizona, is slowly working on its line from Ash Fork south and a number of branches are under construction and survey in Colorado. Aside from these the several projects under way are sufficiently described in the detailed list.

HIGH SPEEDS ON RAILWAYS.

The attainment of the ideal railway speed of 100 miles an hour by American locomotives seems now pretty well assured, the record having been raised in about 15 months from 90.5 miles to 91.7 miles and 97.3 miles per hour. The latter speed was attained by an engine and train of four cars on the Central R. R. of New Jersey, Nov. 18, as already noted in our columns, and details of the engine and its record-breaking run are given elsewhere in this issue. When in 1887 a regular train on the New York, West Shore & Buffalo R. R. attained a speed of 84 miles an hour there was considerable doubt expressed as to the accuracy of the record until it was officially authenticated. In 1886 a two-cylinder compound locomotive, with train, on the Northeastern Ry., of England, made a record of 86 miles an hour, and this remained the world's record until August, 1891, when a simple engine with one car, on the Philadelphia & Reading R. R., made a record of a mile in 39.8 seconds, or at the rate of 90.5 miles an hour. In February, 1892, a four-cylinder compound locomotive, with train, on the Central R. R. of New Jersey, made a mile in 39.4 seconds, or at the rate of 91.7 miles an hour. On Nov. 18, the same engine, with a regular train of four cars, raised the record to 38 and 37 seconds, or 94.73 and 97.3 miles per hour respectively. The weight of the train was about 280,000 lbs. or 485,800 lbs. including the engine and tender.

There are three points of special interest about the locomotive which holds the three highest records of the world: First, the use of the compound system; Second, the use of driving wheels of large diameter; and, Third, the use of a special form of valve. The boiler pressure is high, 180 lbs. per sq. in., and this pressure was maintained steadily during the run of 89 miles from Philadelphia to New York, during which the high speeds ranged from 80 to 97.3 miles per hour. But 180 lbs. working pressure is being very widely adopted on American railways. Engines have been built in England to carry a pressure of 200 lbs. per sq. in., but the working of the valves (which were of the ordinary slide-valve pattern) was not satisfactory and the pressure was reduced to 175 or 180 lbs. Whether the adoption of some different pattern of valve will enable the higher pressure to be carried in service without detriment to the performance of the engine remains to be seen. The use of compound engines for express service is extensively practiced on railways in the United States and in foreign countries, and engines of the two-cylinder, three-cylinder and four-cylinder compound types are in regular and successful service. Some American railways are experimenting with different types of compound engines in competitive service, and the compound system generally, which was first introduced on European locomotives, has made and is making very much more rapid progress in this country than in any other. It is being adopted for all classes of service and for all types of locomotives, as has been clearly shown from time to time in our columns.

Within the last year or two there has been a very extensive change of opinion, and consequent modification in practice, in regard to the size of driving wheels. Fast trains were run, but the trip generally averaged a moderate rate of speed, and it was frequently stated that the use of large wheels was unnecessary and even undesirable. A diameter of 6 ft. was exceptional, and a very common size for the driving wheels of express passenger engines was 5 ft. 8 ins. This was the diameter of the wheels of the New York, West Shore & Buffalo R. R. engine above referred to, which broke the record in 1887, and also of the wheels of some of the first engines that in 1891 hauled the Empire State express on the New York Central & Hudson River R. R. This is the fastest long distance train in the world (running 440 miles in 8 hours 40 minutes, with four stops, or at the average running speed of 52.12 miles an hour). One of the engines hauling this train had driving wheels 6 ft. 6 ins. in diameter (Eng. News, Sept. 19 and Oct. 31, 1891), and proved so satisfactory that similar engines were built for the express service. Four or five roads are now using driving wheels 6 ft. 6 ins. diameter on their express engines, and the New York Central & Hudson River R. R. and the Pennsylvania R. R. are both trying engines with 7-ft. driving wheels. The form of valve used on the engine which holds the record is a hollow piston valve (Eng. News, May 3, 1890, and Feb. 20, 1892), designed by Mr. S. M. Vauclain and used on all his four-cylinder compound engines. It effects a rapid distribution of the steam with ample port area. It may be that with this or some other modified form of valve a still higher working pressure can be carried than is practicable with the ordinary slide valve without affecting the performance of the engine, as already noted.

In our issue of July 21, 1892, we discussed the views expressed by Mr. Charles Rous-Marten on high-speed locomotives, in which he advocated a single pair of driving wheels of large diameter, high boiler pressure, and cylinders of short stroke and large diameter. The success of engines with four coupled driving wheels (and even six coupled wheels for fast heavy trains) makes it improbable that single driving engines will be introduced in this country, but that Mr. Rous-Marten's ideas as to the size of the wheels and the proportions of the cylinders are correct appears to be shown by the latest practice in express engine construction, for, as shown by the table of express locomotives in the issue above referred to, the stroke of cylinders is generally 24 ins. In the course of correspondence Mr. Rous-Marten expressed considerable doubt in regard to the speed of 91.7 miles an hour attained in February last (mentioned above) looking upon it as an irresponsible newspaper statement, but we were enabled to assure him of the correctness of that record and to present indicator diagrams taken at that speed (Eng. News, June 9, 1892). In a letter received last week from Mr. Rous-Marten, now in New Zealand, he says the 90.5 and 91.7 miles an hour are remarkable and "there must be something in the balancing or compounding of your engines, in the setting of the valves or in the exhaust, which enables you to achieve results hitherto impracticable elsewhere." As will be seen by the particulars given above and in another column, the engine which made the 91.7 miles record and has since raised it to 97.3 miles an hour is a compound engine with a special form of valve, and, owing to the use of the compound system, has a soft exhaust. As to the balancing we are not advised of any special or new arrangement.

Having now practically reached the much-talked of speed of 100 miles an hour, we have to meet three conditions of the operating of traffic at such high speeds: First, to build engines capable of maintaining such very high speeds; Second, to equip the trains with brakes which will put them under even better control than ordinary trains at 30 to 50 miles an hour; and, Third, to improve the track and railway generally by means of block signals, elimination of grade crossings, etc., so that the trains may run in safety. As to the first condition, there is probably little difficulty in meeting it with well built engines of good design, ample strength of working parts and generous bearing surfaces. The second condition is more difficult, and even Mr. Westinghouse appears to be doubtful of the possibility of meeting it in every-day service. The third condition involves no difficulty except in so far as the money question is concerned, and is already being met by some of the leading railways as has been shown from time to time in our columns. Block signal plant is expensive, but it is in our opinion a necessity in the safe operation of heavy traffic, without regard to such exceptional

speeds as we have been considering. Properly built bridges, with solid floors, would not be affected by the increase of speed of passing trains, and such matters as the elimination of railway and highway crossings at grade, the replacing of old and weak structures, and the exclusion of passengers from the track at stations, meet the approval of railway managers and officers in general, even if they are not able to carry them out on their own lines. It will be noticed that during the fast run on Nov. 18 the train was flagged two or three times, and the greatest speed was attained on a division thoroughly equipped with block signals.

The question of running trains at speeds of 80 to 100 miles an hour is an interesting one to railway men and the public at large and has been discussed in our columns and in papers by practical railway men (Eng. News, Nov. 7, 1891, June 9, July 21 and Nov. 17, 1892), with no very decisive results, except the general one that the limit of practical possibility has not yet been reached, but is not likely to be enlarged greatly very soon for regular service. Further developments in train performance may be looked for, but at present the Central R. R. of New Jersey, with engine No. 385, holds the world's record for the highest actual speed, and for the fastest mile run.

THE CIVIL ENGINEERS OF THE U. S. NAVY.

Capt. N. H. Farquhar, U. S. N., Chief of the Bureau of Yards and Docks, in his last report to the Secretary of the Navy strongly recommends the increase of the present staff of civil engineers employed by the Department. He proposes that there shall be 20 civil engineers in all, 12 engineers and 8 assistant civil engineers, and further recommends that the assistants be selected from graduates of the Naval Academy who show an aptitude for civil engineering and who shall be given a further course at some civil engineering school.

The rapid increase of our navy requires a reconstruction in great part of our older yards on a scale commensurate with the new demands, and the building of new yards and new public works of all kinds. The present pressing need for the services of assistant civil engineers is now met, partially and imperfectly, by employing young engineers from civil life, who have various ratings in the navy and are paid out of general appropriations. Captain Farquhar believes that it is to the manifest advantage of the service to have these engineers permanently attached to the navy, recognized as commissioned officers and thoroughly trained in the subordinate grade and thus better fitted for promotion to the more responsible positions as vacancies occur.

There is no doubt that the good of the service requires thoroughly trained civil engineers and that this training can best be secured by permanently employing in this special service, with later promotion to the higher grades. The recommendation that the assistant engineers be selected from graduates of the Naval Academy is also an excellent one, as qualified by the Chief of Bureau. It certainly is to the advantage of the engineer thus employed to have a general knowledge of naval matters, and the requirements that the graduate of the Academy be further educated at an engineering school, presumably specially selected for this purpose, assures the thorough technical training of the young engineer. Under the present system the assistants have no recognized status in the naval service and the few hard-worked civil engineers regularly enrolled in the navy have no legitimate successors. In the past all engineers thus employed came from civil life as the demands of the service required, and they have done most excellent work. But the reconstruction of our navy and its future maintenance, and the late very radical advance in all things pertaining to the building and care of warships, make it especially desirable that more civil engineers be permanently attached to the service and that some intelligent plan be adopted for regularly recruiting this special staff and for properly training the younger men. For this purpose we can suggest no better plan than that recommended by the Chief of the Bureau of Yards and Docks, in his last report. The graduates of the Naval Academy certainly exceed in general attainments the average young man entering upon an engineering course; and if from these graduates those are selected for a thorough and special technical training who show real aptitude for civil engineering the resultant engineer should be remarkably well qualified for the subordinate grade in the service which he will be first called upon to fill. As we understand the recommendation of Captain Farquhar the Government will also pay for the engineering education of the selected graduate, and under these conditions it would doubtless be the best the world affords.

As to the present civil engineering staff of the United States Navy, the number is limited to ten men. Of these two are usually attached to the Bureau of Yards and Docks, in Washington, and at least two more, Mr. A. G. Menocal and Mr. Robert E. Peary, are not available for active duty. Mr. Menocal has been long on leave of absence in connection with Nicaragua Canal affairs, and Mr. Peary, just returned from Greenland, has been recently granted a three years' leave of absence for further exploration in the same remote region. With eleven naval yards and stations now in operation and others in contemplation it is very evident that six civil engineers are not enough to go around. According to the Naval Register of 1891, the last issue at hand, the rank of these ten civil engineers was as follows: One had the relative rank of a Captain in the United States Navy; two had the rank of Commander; three ranked as Lieutenant-Commanders and four took relative rank with Lieutenants. Taking the sea-service pay of the above named officers in the Navy as a guide we find that salaries received by these four grades of civil engineers range from $4,500 per annum to $2,400; what the pay of the proposed assistant engineers would be can not now be stated. It is safe to say, however, that the Government will, on the plan suggested, receive the full value of the money it invests in educating the assistant, and will retain his services for a less sum than it would pay for equalled trained young men from civil life who have no permanent place in the naval service. With the status of the civil engineer properly established in the United States Navy, we may yet hope to see the best fitted of the engineering staff at the head of the Bureau of Yards and Docks, and that office filled as are other staff bureaus. A mechanical engineer now heads the Bureau of Steam Engineering; a paymaster is chief of the Bureau of Provisions and Clothing; and a surgeon presides over the Bureau of Medicine and Surgery. Why not put a civil engineer in charge of what is emphatically a civil engineering bureau?

The Chicago & St. Louis Electric R. R. Co., which proposes to build an electric railway from Chicago to St. Louis, as described in our issue of Feb. 20, and June 9, 1892, is endeavoring to secure capital for its work. It recently offered for public subscription stock amounting to $500,000, at one-half its par value, and has been endeavoring to float $3,000,000 worth of its bonds in New York city. The company states that it has completed eight miles of roadbed and one of its power-houses at Edinburg, Ill., has finished the permanent location of its line, and secured about 60% of the right of way, and has acquired the title to 1,000 acres of coal rights, the best equipped coal mine, brick and tile making plant in Illinois, and sites for depot, car-shops and power-houses. The company is reported to have let contracts for boilers of 20,000-HP. to the Hawley Furnace Co., of Chicago; for the locomotives to a Philadelphia firm, and for the electric motors to a firm in Frankfort, Germany. It is said to be now receiving bids for steel rails and for fencing. The company's estimate of its annual revenue is $2,895,000 (which includes $1,000,000 for light and power distribution along its line), while it sets its operating expenses, including depreciation of plant, wear and tear, etc., at $450,000 per annum. Deducting $420,000 for interest on its bonds this leaves over $2,000,000 net earnings, which is certainly a sufficiently roseate prospect. Prof. Francis E. Nipher is President of the Company, and Mr. C. E. Bleyer, The Temple, Chicago, is Assistant General Manager.

The Philadelphia city hall has cost $15,000,000, with the site obtained for nothing. The interior finish on half the rooms remains to be done, and the great iron tower is yet to be completed. This building was commenced in 1870, covers 184,231 sq. ft. and is six stories high. The highest point of the statue of Wm. Penn surmounting the tower will be 547 ft. 3½ ins. above the pavement. It contains 750 rooms, with a floor space of 14½ acres.

LETTERS TO THE EDITOR.

WIND STRESSES IN IRON BUILDINGS.

Sir: The engineer of a bridge works in the West calls my attention to an error in equation (10) of my analysis of wind strains in iron structures, published in your issue of Nov. 10. The second member of the equation should have a minus sign before the first term. The error is an important one and not easily detected.

Very truly yours, Geo. H. Hutchinson.

Pittsburg, Pa., Nov. 21, 1892.

THE FIRST QUADRUPLE EXPANSION ENGINES.

Sir: You state in your issue of 17 inst. that "America appears to be in advance of England in the use of quadruple expansion engines for stationary services." Please allow me to inform you that Daniel Adamson, of Hyde, near Manchester, England, more than 12 years ago (the exact date I do not remember), built a quadruple expansion engine for driving the machinery of one of the neighboring cotton mills. The cylinders were 17, 22½, 30¼ and 42-in. diameter, and 5-ft. stroke.

Yours truly,

Milwaukee, Wis., Nov. 25, 1892. Herbert Axford.

DESIGNATION OF POINTS OF CURVATURE.

Sir: In your issue of Nov. 17, 1892, in editorially commenting upon the "B. C." and "E. C." you say that the objection advanced to "P. C." and "P. T." is "only the theoretical one that, geometrically speaking, both the "P. C." and "P. T." are points of tangency and points of curvature as well."

Is not the proposed "B. C." and "E. C." open to a similar objection? Does not their theoretical correctness depend also upon the supposition that the line runs in the direction of the stationing? The advantages of a uniform nomenclature are universally conceded, and it seems very unwise to tinker with an existing one unless a decided gain can be made in clearness; brevity, also, being considered.

Yours truly,

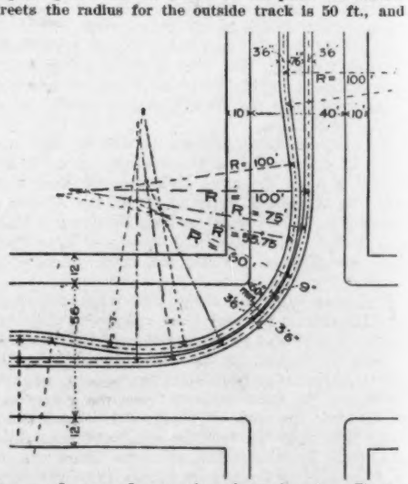
C. F. W. Felt.

Ridgway, Colo., Nov. 24, 1892.

(They are open to the same objection, and thoroughly illogical. Unfortunately, there are one or two published field-works which use "B. C." and "E. C.," and help to perpetuate an absurdity, but it is to be hoped that the practice will gradually die out, as all other absurdities do in time.—Ed.)

TRANSITION CURVES ON STREET RAILWAYS.

Sir: I send you a tracing showing plan of curves generally used on the electric railway in Los Angeles, Cal. As the minimum distance from the curb to the inside rail had to be 6 ft., I recommended the method of placing the rails as shown on the plan. In narrow streets the radius for the outside track is 50 ft., and



Street Corner Curves for Los Angeles Electric Railway.

both tracks have reversed curves at each end similar to the one shown on plan. Transition curves have been adopted on the whole line and the form used is mostly the cubic parabola.

Yours respectfully,

Thomas J. Rask.

Gila Bend, Ariz., Nov. 22, 1892.

(An objection to this sketch would seem to be danger of possible side collision on the curve if the street corner was solidly built up, and it would seem better to use four radii rather than two only.—Ed.)

OBSERVATIONS OF RIVET VALUES

Sir: In answer to the inquiry of Mr. Gravelle in Engineering News of Dec. 1, I find that some data of the kind he desires were obtained in some tests made at the Watertown Arsenal for the Bureau of Steam

Engineering, U. S. In his account of these tests, Prof. Lanza says (see Lanza's Applied Mechanics, latest ed., p. 420):

"After testing from a number of joints, the rivet-heads were planed off, the rivets driven out, and butt-straps removed, thus giving access to the rivet holes in the plate, which were then measured and their elongation recorded on the sketch.

"From these figures the transmission of stresses to the different rows of rivet-holes may be approximately judged of."

I am unable to find these figures in Prof. Lanza's book, but if Mr. Gravelle has access to the government reports of tests he can probably find them there. If not, perhaps they might be obtained from Mr. Howard, who has been in charge of the Watertown tests for a number of years.

These are the only experiments of which I have any knowledge, in which any measurements were taken from which the proportion of the stress borne by different rows of rivets could be even approximately deduced.

Very respectfully,
Charles W. Sherman.

Ithaca, N. Y., Dec. 2, 1892.

EUROPEAN STREET CAR PRACTICE.

Sir: In the editorial upon the Broadway franchise sale that appears in the last number of Engineering News, your assertion about seats being provided for all passengers by the street car and omnibus lines of the different cities in Europe is rather too sweeping. You say, "In no city of Europe, so far as we now recall, is any public carrier permitted to carry more passengers than the vehicle will seat." In a number of cities—notably in Holland (which has, by the by, the neatest and nicest cars upon its lines that I have seen anywhere), and Italy—passengers are allowed to stand both upon the front and rear platforms. Generally, however, a certain definite number only is allowed on either platform, this limit occasioning no crowding; this rule may be a universal one. In some cases a less price is asked for those occupying the forward platform. I feel pretty sure that I have seen the same practice in other countries, but am not quite certain.

I have also seen straps for standing passengers in the interior of some street cars, the same as are used for hanging to in our own cars, but I cannot remember positively if I have seen them in use. It may be that their use is allowed on extraordinary occasions only.

I write this only to set your right on a minor point of the carrying capacity. It is but natural that they gestions about the course that should be pursued in disposing of such an important franchise as that for rapid transit in New York City.

Very truly yours, J. F. Flagg.

(We are inclined to think our correspondent is correct, to the extent that many lines count in a certain limited number of standing places as part of the seating capacity. It is but natural that they should do so, where standing passengers do not crowd others, in view of the known fact that many passengers prefer to stand outside when they have the choice. Some of the Paris street car lines permit this, we now recall. But the general rule that no more passengers may be carried than can be seated or carried with about equal comfort to themselves and no discomfort to others remains still unbroken by any European practice.—Ed.)

EFFECTS OF OVER-DRIVING OF PILES.

Sir: A late issue of Engineering News contains an invitation for further comment upon the subject of pile driving. The interesting paper read by Mr. J. Foster Crowell, C. E., before the American Society of Civil Engineers, and its discussion, with your editorial articles thereon, would seem to cover the matter well. There has been a deal of theory on the subject, but as all has been derived from practice, two simple practical points not alluded to may be of service.

Many years ago engineers used to be instructed and required to drive piles to a very small movement at the last blow, even so low at times as ¼ in. Common sense rebelled at this, and so soon as the writer came in responsible charge of work, he seldom permitted it. In 1879, an ocular demonstration not only showed the correctness of this long held position, but caused a loss of faith in piles driven to small movements for many cases.

The projected line of the Boston, Hoosac Tunnel & Western Ry. passed under the Troy & Greenfield (then in operation), in two places, both of which were at embankments of sand. After some years of litigation the first named road was permitted to be completed; naturally it derived no assistance from its opponent. For the proposed openings, to be spanned by iron bridges on masonry abutments, temporary bents of piles were driven in the embankments to about 22 ft. below track level of the T. & G. R. R., to allow excavation for the abutments, etc., at the under crossing. The fine compact sand caused hard and slow driving. In the subsequent excavation which soon followed it was found that over one-half of these piles were next to worthless, being split or broken from the driving at depths below 8 ft. in one or more of the three ways indicated by accompanying sketches; and in these cases the bents had to be "posted down."

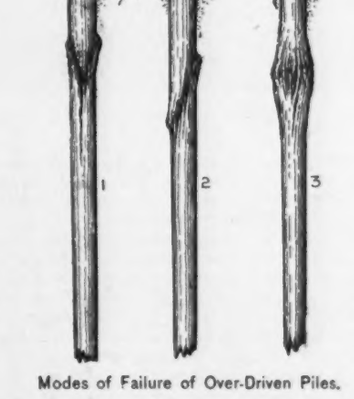
In the articles alluded to there is mentioned the bad effect of "broomed heads," but broomed points are hardly touched upon, which naturally brings up a second practical point early learned, about which many engineers and contractors will differ with the writer until they may make fair trial.

In most kinds of materials a pile will drive better, truer and nearly as rapidly, if merely cut off square at the lower end than if pointed; and, strangely enough, this proved so even in indurated sand where marking stakes required pointing or holes made for them. Although cutting off piles saves labor of handling and pointing, yet only a demonstration convinces engineers and contractors of the benefit; once tried, however, neither will thereafter point, except under "cast iron specifications."

Robert L. Harris, M. Am. Soc. C. E.

New York, Nov. 30, 1892.

(Our correspondent informs us verbally that most of the piles failed as shown in Fig. 1; some of



Modes of Failure of Over-Driven Piles.

them, however, as in Fig. 2, and a few only as in Fig. 3. His point that piles will, as a rule, drive better without sharpening than with, is now, we believe, generally accepted practice. An iron shoe, if used, is also of very little assistance, generally stripping off before it has penetrated far.—Ed).

SOME FACTS OF EXPERIENCE IN PILE DRIVING.

Sir: I have read with considerable interest the discussion of Mr. Crowell's paper upon "Uniform Practice in Pile Driving," more, I must admit, from curiosity than with the expectation of arriving at a successful solution of the problem. A review of all that has been said but confirms me in the opinion that the conditions involved are such as to preclude the possibility of their being expressed by a formula that shall be of any practical value; by which is meant a formula that will enable an engineer to determine, from such observations as he can make upon a pile while being driven, its ultimate resistance to further settlement in actual service. A simple comparison of the results given by the several formulas printed in Mr. Crowell's paper is alone sufficient to indicate quite clearly that we have not yet accomplished much in this direction. It is true, any one of the equations will sometimes yield results agreeing fairly well with practical cases, but unless some means exist of determining under just what conditions it will fail to do so, we are taking chances that have no place in good engineering.

All of the pile formulas with which I am familiar, except perhaps Professor Rankine's,* may be more or less directly referred to the general expression

$$R = \frac{w\,h}{s}$$

in which "s" is assumed to be the measure of the resistance to penetration. That this is true for "s" due to any blow of the ram at the time that blow is delivered, is very probably correct, but inasmuch as this "s" depends upon the individual and peculiar properties of the soil into which the pile is driven, before we can logically extend the range of our formula beyond this point we must be prepared to show that these properties continue to exist as they did at the time the blow was struck and continue to affect the pile in the same way. Even should we succeed in this, a further difficulty presents itself in the necessary assumption that the conditions of loading in actual service are analagous to the blow of the ram, or at least sufficiently so to enable us to infer from the behavior of the pile in the latter case how it will deport itself in the former. Possibly we can sometimes safely make such assumptions, but when this should not be done, we have no means of ascertaining. I am not to theorize, however, and will confine further remarks to examples met with in my individual practice, selecting those instances that will emphasize the opinion I have expressed that no formula can, under all circumstances, give correct results, and unless the means are at hand for determining when it will fail to do so, it is the part of the prudent engineer to distrust it in all cases.

Several years ago, being called upon to design and construct certain railroad terminals, a large portion of which was to be located upon a soft marsh averaging probably 70 ft. in depth, it became necessary to determine with a reasonable degree of accuracy the supporting capacity of piles driven into, but not through the stratum. This was particularly necessary as much of the work was to be of a temporary character where it was inadvisable to incur the expense of securing piles long enough to penetrate to the solid bottom.

The following test was made:

A pile driver was selected and the guides graduated so that the fall of the ram could be readily noted for each blow, as well as the penetration of the pile and its depth in the ground. A pile of known length, 12 ins. square, (weight 1,500 lbs.), was secured. The ram weighed 1,950 lbs. and was tripped automatically at the zero point on the guides. The result of the first pile test is tabulated below:

No. blow.	0.	0.	1.	2.	3.	4.	5.	6.	7.
Fall, ft.	0.	0.	10.5	13.	15.	16.5	19.	20.5	22.5
Set, ft.	5.0	6.5	2.5	2.0	1.5	2.5	1.5	2.0	1.5
Depth in ft.	5.0	11.5	14.0	16.0	17.5	20.0	21.5	23.5	25.0
Contact surface sq. ft.	20	46	46	56	64	70	80	86	94
Coefficient of resistance lbs. per sq. ft.	445	453	457	460	463	465	472		

(The last line is obtained by dividing the total energy of the blow in foot-pounds (fall in ft. × wt. hammer in lbs.) by the area of surface of the pile in contact with the earth. We have checked through the computations, and find them correct, but the large and round figures for the set have a somewhat suspicious look.—Ed.)

It is curious to note how uniform the coefficients in the last line above are, and it may be a fair conjecture, whether the gradual increase from 445 lbs. per sq. ft. under a fall of 10.5 ft. to 472 lbs. per sq. ft. under a fall of 22.5 ft. may not be due rather to the loss of energy as the fall increases than to an actual increase in the coefficient itself. These seem to me too great to be attributed to the friction of the mud upon the sides of the pile, when the short interval between the successive blows of the ram is taken into consideration. It is of course impossible to determine, without experiments specially directed to that end, how much may be due to the resistance at the point of the pile. The data therefore have no special bearing upon the present discussion and are only given for what interest they may possess. Similar records were made of over 100 piles, and more or less complete observations upon more than 1,000 piles driven in the same locality, serve to confirm the general character of the special tests made.

In order to ascertain what increase in stability the piles would probably acquire over that indicated by the excessive settlement at each blow of the ram, several tests were made by carefully noting the penetration at the last blow, and suspending operations for twenty-four hours, at the expiration of which, driving was resumed. In almost every instance the penetration at the first blow was but one-fifth of what it had been under the last blow on the previous day, gradually increasing after two or three blows, until the full penetration was reached, showing very clearly that a longer interval, than that between the successive blows of the ram, was required to enable the mud to attain its full grip upon the pile.

One case possesses sufficient interest to be recorded. The pile in question was driven in a temporary trestle, penetrating 40 ft. into the mud and settling 26 ins. under the last blow of the ram, falling about 20 ft.

The ultimate (not safe) sustaining capacity of this pile as determined by the several formulas given by Mr. Crowell would be as follows:

Sanders	18,460 lbs.
Engineering News	18,080 "
Crowell (a)	18,210 "
Trautwine	10,037 "

And yet the location of this pile was such as to load it many times each day with about 18,000 lbs., and after the expiration of two years no settlement could be detected. It is evident that in this particular case the formulas all give too small ultimate loads, because, the conditions upon which they are based are not those which control the actual supporting capacity of the

* This formula, curiously enough, measures the resistance to settlement, by the sectional area of the pile, while assuming the entire support be derived from the friction upon its sides.

pile, in common with the test piles, would show only 5 1-5 ins. penetration after a rest of 24 hours. If this was done, the results given by the formulas would be more in keeping with the facts. But the necessity of having to handle a formula in this way certainly does not tend to establish confidence in it, because this kind of "s" would not be the penetration at the last blow, but the penetration at the first blow after a definite period of rest. Nor does it seem to me that a variable coefficient of safety would be a rational remedy, for to intelligently apply such coefficient, we must know the ultimate resistance. It is very true that if the bearing capacity of this pile be determined by the formulas, the result would be amply safe, but it does not require very careful scouting to see how much the expense of the work would be increased over the amount actually necessary to accomplish the desired result.

Contrast the foregoing example with another case. A similar work was undertaken in a different locality, but the character of the strata through which the piles were driven differed in every respect. The marsh was underlaid at varying depths by a hard bed of sand. The overlying mud being so soft that one or two blows of the ram would drive the pile down to the sand, in some instances more than 30 ft. Tests indicated that after the expiration of 24 hours of rest, the conditions remained unchanged. The first blow of the ram causing the same penetration as did the last blow on the previous day. It was evident, therefore, that the supporting capacity of the piles must be derived from the sand stratum underlying the mud, and into this they were driven, settling at the last blow of a 2,240-lb. ram falling 25 ft., from 1½ to 3 ins. The underlying stratum of sand varied in depth, and in several instances single sections of piles were not of sufficient length. It was, therefore, necessary to drive one or more additional sections upon the first, the connections being made with ordinary dowel pins. Estimating the bearing capacities of these piles by formula, the following comparison (taking s=2 ins.) may be had:

	Gross.	Safe.
Sanders	336,000	42,000
Engineering News	224,000	37,333
Crowell (a)	292,180	48,697
Trautwine	109,013	54,506 to 9,085

The conditions of loading to which these piles were subjected, were in every way similar to those mentioned in the previous case; and yet, all of the single piles settled appreciably, while those composed of two or more sections, end to end, yielded but slightly or not at all.

I do not know of two instances that more forcibly illustrate the effect of the material penetrated. In the first instance, the ultimate sustaining capacity of the pile, by formula, is but 18,080 lbs. while in actual and almost hourly service this load was reached without causing further settlement for two years at least. While in the second instance, although the indicated ultimate resistance by formula is over 200,000 lbs., and the safe load, by the most conservative (Engineering News) formula, 37,333 lbs., the piles have failed at less than one-half that amount. It is worthy of special note, and I shall refer to the fact later, that in the second example the single section piles showed appreciable settlement while those composed of one or more sections did not.

In contrasting the two cases the reasons for the differences are not for to seek. In the first case the marsh mud was of a peculiarly tenacious character, tough and sluggish in its movements. Having been displaced by the pile in driving it required a considerable time to restore itself to grip the stick, but once having done so, it possesses sufficient elasticity to admit of considerable lateral displacement without breaking away. But in the second case the point of the pile was in sand, a material not possessed of these properties, and, although the piles were fairly well driven as regards the settlement at the last blow, the continued vibration set up by passing trains being transmitted to the point, gradually worked them down. This vibration, although affecting in like manner those piles composed of two or more sections, was dissipated in the upper sections, and failing to reach the point, could not produce that disturbance of the sand necessary for settlement to take place. I believe this to be the explanation of the stability of these double section piles.

The tendency of piles driven in sand to work themselves down if exposed to vibratory motion, is well known, and seems to be entirely independent of the settlement at the last blow of the ram. In my own experience I have known very many to settle under a load of about 18,000 lbs., although driven to ⅛-in. settlement with a 1,200-lb. ram falling 20 ft.; principally, I believe, because the limit of penetration, ½ in., would be reached before the pile had been driven deep enough to prevent its rocking, so to speak, on its point. I cannot now call to mind a single instance of piles driven into the sand and exposed to vibrations that have not settled more or less unless driven quite deep. It is my practice, and has been for some years, to require all piles to attain a certain minimum depth, regardless of how small the penetration at the last blow may be, unless some firm and reliable stratum can be reached.

In conclusion, if it can be established, as I think, that the individual peculiarities and properties of the soil penetrated must appear as a factor in any expression for the bearing capacity of a pile, and that factor cannot be measured by "s," I do not see how it is possible to use any formula without expending as much labor in determining the particular constants and coefficients necessary, as would be involved in making an actual test upon the ground by piles driven and loaded. Many other instances might be given which would seem to indicate a like conclusion, but I have already occupied more of your space than I had intended.

W. B. W. Howe, Jr.

Knoxville, Tenn., Nov. 25, 1892.

(What would our correspondent propose to do, simply guess at the bearing power of piles? This seems to be the legitimate inference from the opinions he expresses, but the facts which he advances in support of those opinions seem to us quite consistent with the opposite view; viz., that a proper formula properly used will at least let a man know when he is or is not within the limits of safe practice. Taking up his examples seriatim the first one is not accompanied by any evidence of bearing power. By the Engineering News formula their safe bearing power would be

$$\frac{2 \times 1{,}950 \times 22.5}{18 + 1} = 4{,}650 \text{ lbs.}$$

if measured by the penetration without intermission after blows. If in this set, as in the one next given, the penetration after 24 hours was only one-fifth as great, the safe load would be increased to about 19,050 lbs., the ultimate being in each case six times as much.

In the next case, the safe load was found to be 18,000 lbs., whereas the several formulas (excluding that of Trautwine, which was erratic) showed an ultimate of only 18,080, the safe load by formula being only 3,013 lbs. But if, as stated, the penetration was only one-fifth as great after 24 hours' rest, the safe load by formula becomes about 15,000 lbs. and the ultimate 90,000. Does not the actual 18,000 lbs. check pretty well with this?

The third case presents the very extraordinary result that in piling across a deep and soft marsh those piles which were spliced out to 60 to 90 ft. afterwards stood a load approaching nearly to the formular safe load, while those piles which were ALLEGED to have touched hard bottom without splicing did not stand half the formula safe load! Has it occurred to our correspondent that perhaps his contractor or foreman was trifling with his confidence, and represented the actual status of those unspliced piles differently from what it was? It is against nature that the sand bottom to a deep marsh should be so very irregular as the statement of alleged facts implies; and no formula can possibly be made general enough to cover and

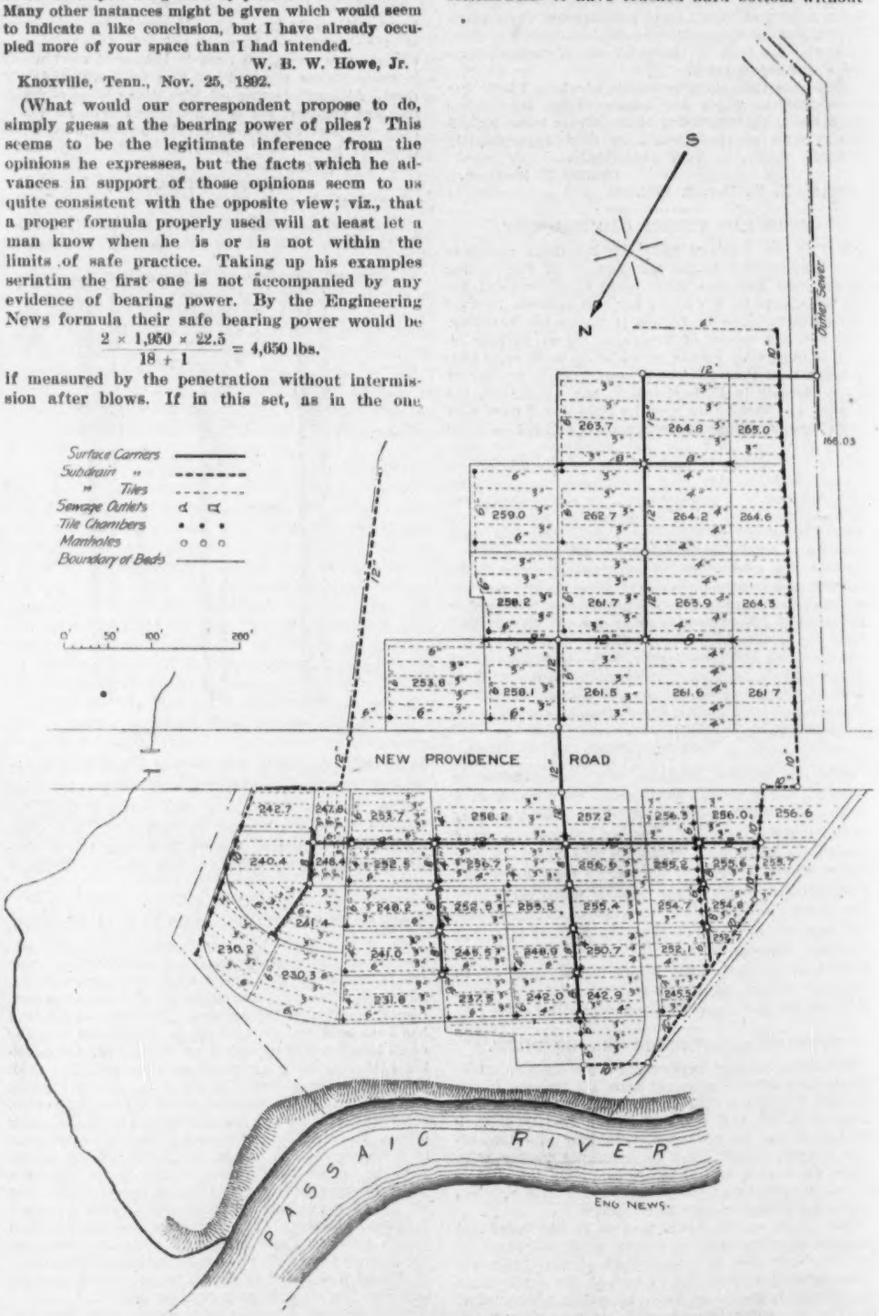


FIG. 45. PLAN OF SEWAGE FILTER BEDS AT SUMMIT, N. J.; Carrol Ph Bassett, Mm. A. Soc. C E., Engineer.

provide for the 'possum element in the soul of a contractor. Nothing but eager eyes can do that, and they not always.

Finally, our correspondent says that he has known short piles driven to ½ in. set by a 1,200-lb. hammer falling 20 ft. to settle under 18,000 lbs. The safe load for such a pile by the Engineering News formula would be

$$\frac{12{,}000 \times 20 \times 2}{0.5 + 1} = 32{,}000 \text{ lbs.}$$

and while agreeing with our correspondent that no pile which has not penetrated a reasonable distance into the earth can be regarded as safely driven, we "dou't the fact," like the Scotchman, that any pile ever rationally driven into sand not underlaid by mud, and under the other conditions stated, has ever failed under a fairly imposed load of 18,000 lbs. Were there not some unstated modifying circumstances or elements of doubt in this case?—Ed.)

SEWAGE PURIFICATION IN AMERICA.

Summit, N. J.

(Continued from p. 521.)

The township of Summit, N. J., is situated 20 miles from New York on the Delaware, Lackawanna & Western R. R. The population of the township in 1890 was 3,502, against 1,910 in 1880. A public water supply was introduced in 1889 by the Summit Water Co.

A sewerage system was put in operation in 1892, the sewage being purified by intermittent downward filtration before passing into the Passaic River. The sewage filter beds were put in operation on Aug. 2, 1892, when there were seven miles of sewers.

At present there are nine miles of sewers, 180 house connections, 20 flush tanks and 168 manholes, all ventilated.

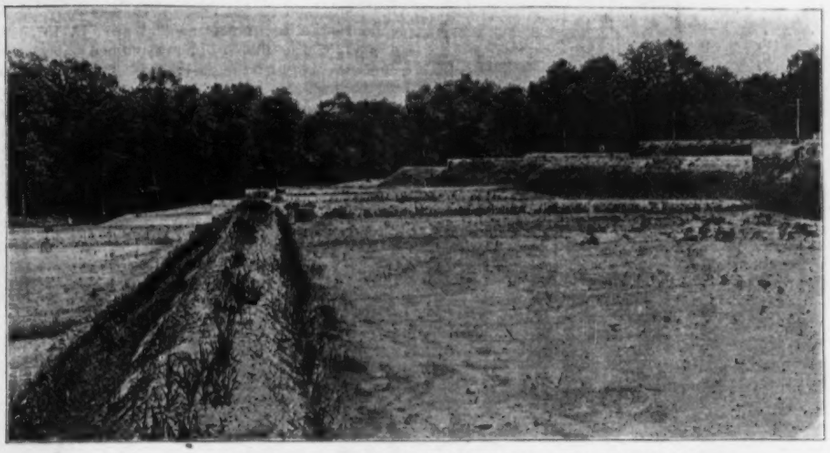


FIG. 46. VIEW OF FILTER BEDS FROM ROAD NEAR NORTHWEST CORNER.

The filter beds are located about a mile from the village, within the township limits. One end of the disposal area borders on the Passaic River, as shown in the plan, Fig. 45. The township owns 26 acres of land, only ten acres of which have been laid out in beds. Deducting the area occupied by embankments and a road there are about eight acres of land available for filtration. There are only a few scattered houses in the vicinity and those are at some distance from the beds.

The sewerage system was designed by Mr. Carrol Ph. Bassett, M. Am. Soc. C. E., who was also engineer for the East Orange purification works, described in our last issue. We are indebted to Mr. Bassett for the illustrations and for some of the information given herewith. Mr. Jas. H. Kelley, Treasurer of the Township Committee, is now in charge of the system, including the beds, and has furnished information regarding it. At present two men are employed at the beds at a monthly expense of about $50.

Mr. Bassett states that a design was made for the mechanical straining of the sewage before it passed to the filter beds, which was to be effected by upward filtration through vats. This feature, he adds, will not be introduced for several years, or at least until a much increased flow of sewage is received at the beds.

A public road passes through the disposal area. The land on the side of the road nearest the river slopes towards the river and the beds are laid out in terraces, as shown by Fig. 46, which is a reproduction of a photograph taken near the lower edge of the tract. The beds are separated by earth embankments. The lowest beds are some 20 ft. above the river. The effluent is discharged at the top of the abrupt river bank and finds its way down the bank into the river.

The writer visited the beds on Nov. 28, 1892, and found the effluent with only a slight cloudiness and but very faint musty odor. The river showed no sign of pollution and there was nothing about the disposal area which indicated to smell or by offense to sight the use to which it was put, except on raising a manhole cover, when a very slight odor was observed.

Regarding the care of the beds the attendant stated that their surface was raked up occasionally. He also stated that no fixed rule was observed as to the length of application of sewage to the beds, judgment being used in that respect. The drawing from which Fig. 45 was made showed one or two beds with no outlets to them, and the original has been followed, but the attendant stated that all the beds laid out are in use.

The general arrangement of the beds, sewage carriers, outlet chambers, manholes, sub and main underdrains and tile manholes to give access to the latter will be seen by reference to the plan, and the accompanying explanatory symbols, Fig. 45. The underdrains are placed with their centers at a depth of 3 ft. below the surface of the beds.

The sewage is distributed to the beds through pipe carried in the tops of the embankments, from which it is drawn through chambers and short lengths of pipe at the corners of the beds, all located as shown in the plan, Fig. 45. The details of the main carrier and branches, including the plugs used to divert the sewage as may be desired, are shown by Fig. 47. Where the beds to be served are at a lower level than the outlet chambers, half tile, flat stone and V-shaped troughs are used to carry the sewage down or to protect the embankment. All the brick chambers and manholes are lined inside and plastered outside with cement and the brick manholes and some or all of the outlet chambers have board covers, painted.

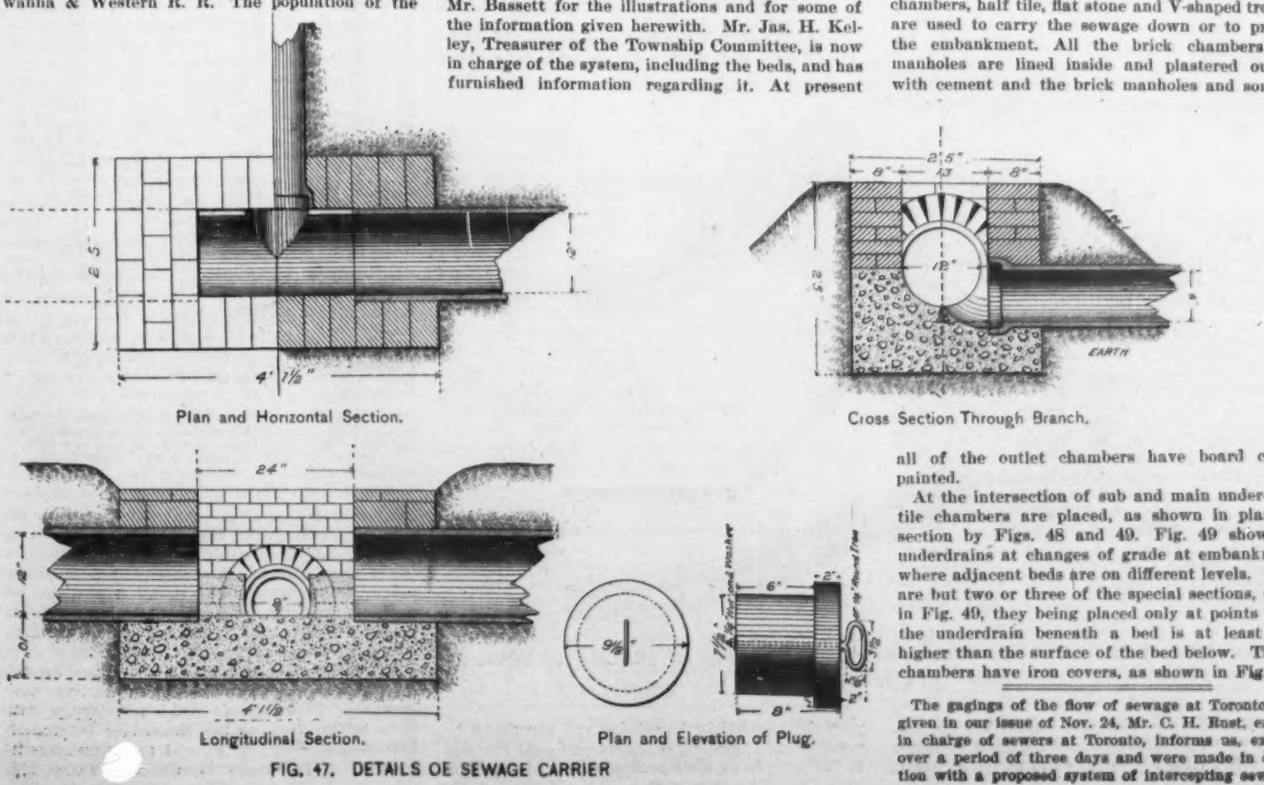


FIG. 47. DETAILS OE SEWAGE CARRIER

At the intersection of sub and main underdrains tile chambers are placed, as shown in plan and section by Figs. 48 and 49. Fig. 49 shows the underdrains at changes of grade at embankments, where adjacent beds are on different levels. There are but two or three of the special sections, shown in Fig. 49, they being placed only at points where the underdrain beneath a bed is at least 2 ft. higher than the surface of the bed below. The tile chambers have iron covers, as shown in Fig. 48.

The gagings of the flow of sewage at Toronto, Ont., given in our issue of Nov. 24, Mr. C. H. Rust, engineer in charge of sewers at Toronto, informs us, extended over a period of three days and were made in connection with a proposed system of intercepting sewers.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.

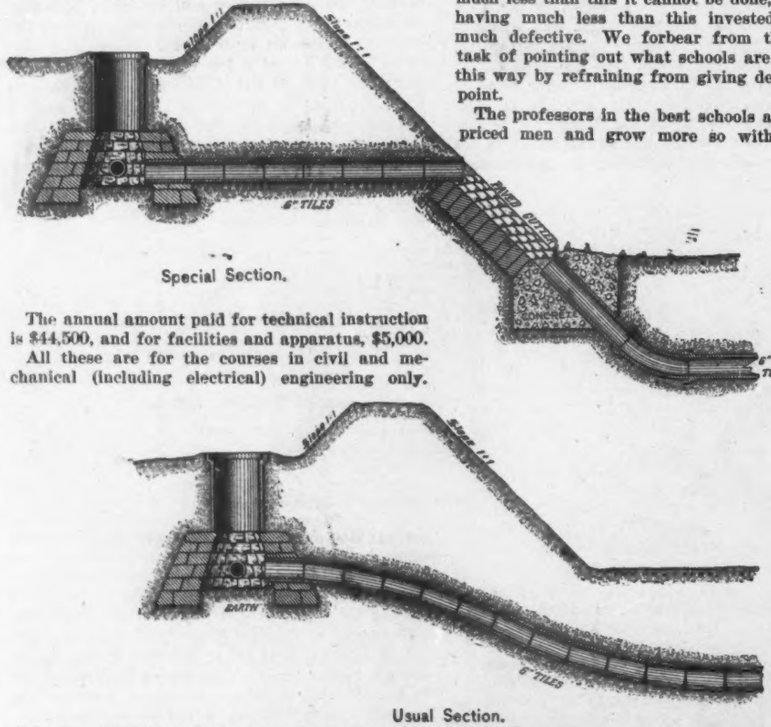
XXXV.

The Cost of Technical Education.

Technical education is the most expensive kind of school training. Not only must the instruction be mostly imparted by specialists, who command (or ought to command) high salaries, but the plant required is very expensive, and the material consumed considerable. It is for this reason that so many of the schools purporting to give courses of instruction in engineering, fail utterly to attain to respectable standing as technical schools. They place the technical courses on the same basis as their literary courses, put them in charge of the traditional college faculty, where the same professor might in time teach mathematics, Greek, Latin, physics, or some branch of science or one or more of the modern languages, and with no other facilities than text books and recitation benches, announce in their catalogues complete courses in "Civil and Mechanical Engineering." This is not so much the fault of the teachers as of the president, who is perhaps a superannuated minister, and of his board of trustees, who perhaps are all good church deacons and bank presidents. Their only idea of a school of any kind is the hearing of lessons learned from books, and why not lessons in engineering as well as in anything else? The greatest impediment now to better educational facilities in even the best schools (with a few exceptions) is the failure on the part of the officers and boards of directors to appreciate the necessity for all these costly appliances. They are often looked upon as the toys or vanities of the professor rather than as essential instruments of education for the boy.

Taking the Cornell University outfit as a type of what the plant of a technical school should be, we have the following category of appliances, aside from buildings and grounds:

Technical library, drawings, etc.	$19,000
Collections, models, etc.	61,000
Surveying instruments	30,000
Chemical laboratory appliances	17,000
Physical " "	43,000
Testing " "	18,000
Steam power plant	31,000
Electrical plant	5,000
Workshop appliances	19,000
Astronomical appliances	13,000



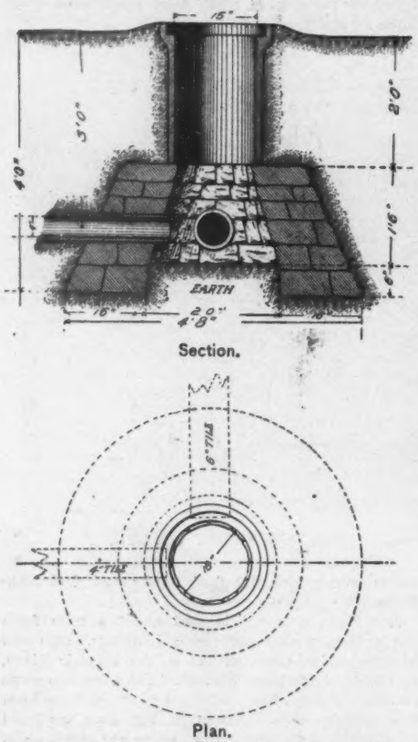
Special Section.

Usual Section.

FIG. 49. SECTIONS THROUGH TILE CHAMBERS AND UNDERDRAINS AT CHANGES OF GRADE AT EMBANKMENTS, SUMMIT, N. J.

The annual amount paid for technical instruction is $44,500, and for facilities and apparatus, $5,000.

All these are for the courses in civil and mechanical (including electrical) engineering only. This college has no course in mining engineering. If to this list were to be added complete assaying, and metallurgical laboratories and sampling works, such are are found at the Massachusetts Institute of Technology, Washington University and various others, it would add some $15,000 additional to the above, and we should have a grand total of $271,000 required to fit up properly a suitable plant for a large engineering school giving the usual courses in civil, mechanical and mining engineering. For much less than this it cannot be done, and schools having much less than this invested are by so much defective. We forbear from the invidious task of pointing out what schools are defective in this way by refraining from giving details on this point.



Section.

Plan.

FIG. 48. PLAN AND SECTION THROUGH TILE CHAMBER.

The professors in the best schools are also high-priced men and grow more so with time. Men properly qualified by knowledge and experience to teach young engineers, can command good incomes in the practice of their profession.

The schools are finding great and increasing difficulty in keeping such men as they have, and it is almost impossible to secure suitable new ones to replace those who drop out. The only remedy is higher salaries. A board of trustees, however, dislikes to pay a professor of engineering more than other members of the faculty receive holding similar responsible positions, and as a result these places are often filled by young graduates with no practical experience, very much to the detriment of the school. Unfortunately, the conditions of the profession do not make it easy to copy the excellent practice of the medical schools, to secure a part of the time of many eminent specialists; but more might be done than is done in this line, we believe.

In the case of an engineering school in a large city, as Boston, New York, or St. Louis, the professors often engage in a consulting or expert practice, and in this way supplement their meager salaries. This is certainly an advantage to all parties concerned, so long as sufficient time is left for the regular college work. The public comes to value scientific and theoretical acquirements, the professor keeps up with the times and is taught to modify his theories by facts, as they should be modified, and the students themselves come to have greater faith and confidence in their teachers, and give greater heed to their instruction.

To pay all these heavy expenses, either the tuition must be very large or the endowments very generous. Those schools which rely largely upon their tuition fees, as the Rensselaer Polytechnic Institute, of Troy, N. Y., and the Massachusetts Institute of Technology, Boston, must charge high

TABLE XXXV.—Tuition Fees and Estimate of Living Expenses at the Several Colleges.

	Yearly tuition.	Diploma & grad. fee.	Living exp., estim.
1. R. P. I.	$200	8	$300@500
2. Harv.	150	....	159@439
3. Yale.	155	10	160@640
4. Dartm.	66	....	300@325
Do. Thayer.	75	....	300@325
5. Union.	90 (incl. r'm.)	12	190
6. U. Mich.	35	10	200
(Mich. students $25, matriculation fee of $25 or $10.)			
7. Br. P. I.	40	....	.....
8. Pa. M. A.	....	....	520 (all told)
9. Columbia.	205	25	250@400
10. Wash. & L.	75	....	135
($12 per mo. bd. in Univ. bdg.)			
11. M. I. T.	200	....	240@320
12. Lehigh.	Free*	....	225@340
13. U. Va.	142	....	158@258
(To Virginians $92 tuition.)			
14. Cornell.	100	5	200@325
(Many free scholarships.)			
15. Tufts.	100	....	152@269
16. U. Ga.	34.75	....	108@180
17. Lafayette.	111	none	150
18. Wash. U.	150	5	215@330
19. U. Vt.	60	....	120@200
20. Kans. Agr. C.	Free	....	160@200
21. Worc. P. I.	150	....	200 +
(Free to rest of Worcester Co. under 21 and to 20 other Mass. students.)			
22. Ala. P. I.	Free	....	.....
23. Me. Agr. C.	30	....	150@200
25. U. Pa.	200	20	150@210
26. Stevens.	150	....	250@450
(If residing in N. J. while a student, otherwise $75 more.)			
27. U. Mich.	Free (8)	....	120@200
29. Swarthm.	200	....	250
($100 less for children of Quakers.)			
31. U. Mo.	40	5	130@200
($1.75 per week all told in club house.)			
32. U. Cal.	Free	....	150@250
33. U. Kans.	Free (10)	5	150 +
34. U. Minn.	Free	....	200@275
35. Rutgers.	75	7.50	175@300
(Forty free N. J. scholarships.)			
36. U. Ia.	25	5	225
37. Corn. C. Ia.	36	....	92@153
38. U. Ill.	Free	....	137@227
39. U. Cinc.	Free (60)	....	.....
40. Princeton.	120	12	171@505
41.			Mean, 397
42. U. Neb.	Free	5	150@450
43. Colo. S. M.	Free	....	200@280
44. W. U. Pa.	100	5	180
45. Pa. S. Coll.	Free	....	200 +
46. Purdue.	5	....	120 +
47. Rose P. I.	75	....	200
49. Mich. M. M.	Free	....	160
50. Mich. A. C.	Free	5	160@125
51. Ga. S. Tech.	Free (150)	....	.....
Va. Mil. Inst.	Free	....	365 all told
(For State cadets $165 all told.)			
Vanderbilt.	55	....	110@180
U. City N. Y.	100	7	.....
U. No. Ca.	77.50	....	120@210
U. Ala.	Free (40)	3	162.50 all t'ld.
Ohio St. U.	15	5	100@300
Delaware C.	60	....	160 +
State C. Ky.	Free (20)	....	143@163
Haverford.	150	....	200

Note.—Where a tuition price is given in parenthesis opposite "Free" it means that tuition is free to residents of the state or city only, and otherwise charged as stated.

* A tuition fee ($100, we believe) has recently been established.

fees. They do charge $200 per annum, but the Columbia School of Mines, which is very largely endowed charges the same. In most of the best engineering schools the annual tuition is $150 and upwards, although some of the very best have free or nearly free tuition.

But even with these large fees, the schools are not self-supporting unless the number of students is very great. In one school reporting these facts, the annual expenditure for instruction and facilities is given as $31,000, while the whole number of engineering students in 1890-91 was but 62. The annual tuition is $150, but this is remitted in many instances, so that, counting out these excepted ones and those who hold scholarships, there are not more than 50 who pay the full amount, producing an income of $7,500 or only about one-fourth the cost of instruction. That is to say, for every $150 the average student pays, some one else pays $450 in order that he may be taught.

In all the state universities the tuition is very low ranging from $10 to $50, and in several of them, as well as in Lehigh* and the new Stanford, it is entirely free, the endowments or annual appropriations paying everything.

We give in the accompanying Table XXXV. the reported cost of instruction and living at nearly all of our engineering schools, which present some interesting and curious contrasts. The first column of the table shows the annual tuition fee, which includes matriculation fee if charged annually (as some of the colleges do charge) but not if it be charged only once. Certain small fees for incidentals which most of the colleges charge (to an average amount of $15 to $30 per year) are also not included, nor are the expenses for drawing materials, chemical apparatus, etc., which some of the colleges cover by a lump sum, and some by charges at cost.

The second column gives the charge for diploma or graduation fee, wherever it was found distinctly stated in connection with the other fees and expenses. In most cases where no fee is specified there is no such fee charged, but this rule is by no means universal. The college catalogues have all sorts of queer ways of specifying such items, and no attempt was made to make this column absolutely complete, as to do so would have involved much labor.

The third column of Table XXXV. gives the estimate in the college catalogue for living expenses of students, including rooms, board, washing, fuel, lights, etc., but not including books, clothes, vacation expenses or incidental college or personal expenses. The totals naturally vary very greatly, being largest at the city or eastern colleges, and smallest (often very small) at the country colleges with dormitories and club houses.

We have not attempted to tabulate the scholarships and other various forms of financial aid to students. Most of the colleges can and do extend some such aid, and many of the older ones have a very considerable amount of such aid to extend. Though it would be obviously injudicious to announce the fact we fancy that few colleges refuse to remit the tuition fees at least to really meritorious students who may be financially embarrassed. Many of the colleges state this in their catalogues, and a few others also state that no student who has once entered upon the course and made a creditable and promising record will be allowed to drop out for lack of means to live upon. The young man who is in earnest can get an engineering education for very little at almost any of the colleges, if he also shows enough ability to make it seem a pity that he should not have the education.

The nominal cost of getting an education, however, has been steadily rising in the past half century, as is but natural. This may be curiously illustrated by the changes in the estimated cost per year at Harvard College, which has gone through the following gradual increase greater at the civil war:

	Tuition.	Other expenses.	Total.
1825 to 1847.....	$90	$100	$100
1848 to 1863.....	75	$110 to 130	$185 to 215
1864 to 1868.....	104	230 to 284	334 to 388
1869 to 1891.....	150	334 to 464	484 to 614

*By a recent action (Oct., 1891), the tuition at Lehigh is no longer free.

At the present time Harvard gives the following four estimates for total expenditures:

Low.....	$372	Liberal.....	$622
Moderate.....	$472	Very liberal.....	$1,010

It is doubtful, however, whether there are any colleges in the country at which the young man who is in earnest can get along on less money than at Harvard and other like eastern colleges, even without relying on scholarship aid beyond enough to cover tuition fees. It is possible for the student who wants to and has to, to live quite sufficiently well in any of our large cities on fabulously little money (experto crede) even without falling back upon college facilities. But board at Memorial Hall at Harvard, with a bountiful and unlimited table in one of the grandest dining halls in the world, is only $4.25 per week, and by joining the "Foxcroft Club," board a la carte can be had for $2.50 to $3.50 without stinting the heartiest appetite. Similar arrangements exist at most colleges.

When the Rensselaer Polytechnic School was organized in 1826 the following was the estimated annual expense of attending it:

Board, 30 weeks, @ $1.50.....	$45.00
Washing about 18 cts. per week.....	5.62
Chemicals, etc., about.....	4.00
Proportion of fuel and lights, about.....	16.00
Text books, about.....	4.00
Experimental term, fees $15.....	30.00
	$94.62

By 1842, when it first blossomed out into a real engineering school, the price of board had risen to $2.50 per week, and some very swell arrangements were announced for the luxuriously inclined, costing about $200 per year, all told, including vacation trips and the like. But it was also announced at the same time that, as few were likely to indulge in such extravagance as this, the rank and file could still get along on about the old figures.

Since then times have changed; not wholly for the better. But it still remains true, and may it ever be so, that the young man who is in earnest and means business, and has any mind to educate, can get an education somehow for very little money at nearly all our colleges. If he does not get it, it is his own fault, or his misfortune in not having a mind equal to his ambitions.

NEW RECORDING PRESSURE GAGE FOR LOW RANGES OF PRESSURE.*

By W. H. Bristol.

Since describing and exhibiting a sinuous tube recording pressure gage** at the New York meeting of the society in November, 1889, many of the instruments have been placed in successful operation; but it has been found impracticable to make gages on the flattened sinuous tube principle which would be sufficiently sensitive to register extremely low ranges or variations of pressure. Such are the variations due to a difference of 0.1 in. head of water, as in the case of illuminating gas in street mains, where the total range rarely exceeds 2 oz. per sq. in., or its equivalent 4 ins. head of water. For such extremely low pressure, it was necessary to offer a very large area for it to act against. This has been accomplished by employing a series of corrugated diaphragms placed as shown in cross section in Fig. 1. The diaphragms are arranged in pairs and joined, as shown, with a continuous opening through the line of centers of the different pairs, thus permitting the pressure to exert itself simultaneously on the interior of every pair, the effect of variations being to produce an elongation of the whole.

This arrangement of diaphragms is employed in the construction of certain self-registering barometers, the small motion of the diaphragms being made available by a train of multiplying mechanism. In the gage now exhibited, the disadvantage of using multiplying devices is entirely obviated by simply securing a flexible strip B along the edges of the diaphragm tube, as it might be called. The effect of applying the flexible strip is two-fold: first, it stiffens the diaphragm tube as a whole; and second, it performs the most important function of resisting the tendency of the pressure to elongate it, which naturally results in producing a greatly multiplied lateral motion.

As in the sinuous tube, the motion thus produced by variations of pressure is ample for directly indicating or recording in connection with a moving chart. By the use of a large number of diaphragms, as shown, it is evident that the change of form of each individual member is very slight for complete range of pressure. It follows that none of the diaphragms will be strained to their elastic limit, and all danger of the gage taking permanent sets will be avoided. In the application of the diaphragm tube to a recording gage it is mounted on a back as shown in Fig. 2. A recording pen is attached directly to the end of the diaphragm tube, and a clock is provided, as shown, timed to revolve a dial, in the plane of movement of the pen, once in 24 hours.

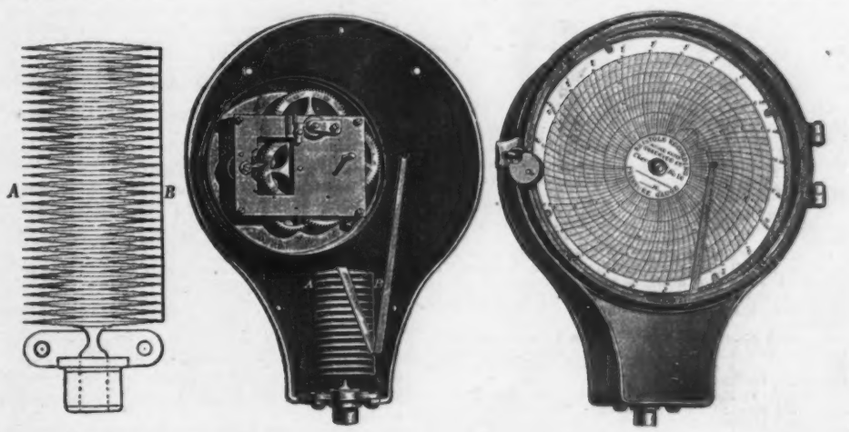


Fig. 1. Fig. 2. Fig. 3.

A RECORDING PRESSURE GAGE FOR LOW PRESSURES.

In Fig. 3 the gage is shown complete, with chart, ready for application. The small graduations on the chart indicate tenths of inches head of water.

This form of tube is not limited to recording gages for light pressures only, as it could be equally well adapted for all ranges if the diaphragms are properly proportioned as to size and thickness of metal. There are other practical applications of this form of tube, if constructed on a large scale, as considerable motion and power could be developed; sufficient, it is believed, to operate directly, without intervening mechanism, regulators, dampers, valves, and especially that class of automatic devices in which pressure is the initial motive power.

*Presented at the New York meeting of the American Society of Mechanical Engineers.

**Trans. A. S. M. E., Vol. XI., p. 225. Eng. News, Dec. 7, 1889.

STATISTICS SHOWING THE PROGRESS AND PROSPECTS OF RAILWAY CONSTRUCTION IN THE FAR WESTERN STATES.

(With Map. No. 46.)

Wyoming.—Existing Roads.

1. Burlington & Missouri River.—Track laid in 1891, Merino to Gillette, 479 miles. Track laid since Jan. 1, 1892, Gillette to Sheridan, 90 miles. Graded, Sheridan to Tongue River, 20 miles. Projected, Tongue River to Helena, Mont., 325 miles.

Projects and Surveys.

2. Big Horn Southern.—Projected, Casper to Custer, Mont., 275 miles.

Total.—Track laid in 1891, 47.9 miles. Track laid since Jan. 1, 1892, 90 miles. In process of construction, 20 miles. Projects of some promise, 215 miles.

Montana.—Existing Roads.

3. Butte, Anaconda & Pacific.—Under construction, Butte City to Anaconda, 20 miles. Projected, Anaconda to Hamilton, 60 miles. F. C. Cruger, Butte City, Mont.

4. Great Northern.—Track laid in 1891, 99 miles west of Pacific Junc. to Kalispell, 162 miles; Monarch to Barker, 10.8 miles; Monarch to Neihart, 13.4 miles. Track laid since Jan. 1, 1892, Mining spurs near Butte City, 4.9 miles; Kalispell to Idaho line, 122 miles.

5. Northern Pacific.—Surveyed, Ft. Benton to Billings, 225 miles; Livingston to Castle, 50 miles.

Valley.—Track laid in 1891, at Helena, 1.73 miles. Located, Helena to Harlow, 13 miles. Pres., Rich A. Harlow; Ch. Engr., W. A. Haven, both of Helena.

Projects and Surveys.

6. Butte City, National Park & Southwestern.—Projected, Butte City to Wyoming line, 150 miles. Pres., Lee Mantle; Cr. Engr., N. C. Ray; both of Butte City.

7. Helena & Castle.—Surveyed, Helena to Castle, 100 miles. J. H. Lawrence, L. H. Hershfield; both of Helena.

8. Helena & Southern Montana.—Projected, Helena to Dillon, 150 miles. Samuel Ward, Helena.

Montana & Wyoming Eastern.—Projected, Helena to Sheridan, Wyo., 300 miles. Pres., D. S. Wade, Helena, Ch. Engr., Geo. Irwin, Omaha, Neb.

9. Montana, Idaho & Pacific.—Surveyed, Butte City to Boise City, Idaho, 400 miles. A. L. Miller, Boise City, Idaho.

Total.—Track laid in 1891, 187.9 miles. Track laid since Jan. 1, 1892, 127 miles. In process of construction, 20 miles. Surveyed or under survey, 468 miles. Projects of some promise, 735.

Idaho.—Existing Roads.

4. Great Northern.—Track laid since Jan. 1, 1892, Montana line to Washington line, 83 miles.

5. Northern Pacific.—Track laid in 1891, Howell to Nez Perces, 20.4 miles. Partly graded, Nez Perces to Tammany, 31.3 miles. Projected, Kootenai Station to International line, 50 miles.

Projects and Surveys.

10. Nampa Ry. & Cons. Co.—Surveyed, Nampa to Silver City, 60 miles. Pres., Pringle C. Jones, South Charleston, O. Ch. Engr., T. D. Babbitt, Nampa.

11. Weiser & Northern.—Surveyed, Weiser to Council Valley, 58 miles. Pres., T. C. Galloway, Weiser.

Total.—Track laid in 1891, 20.4 miles. Track laid since Jan. 1, 1892, 83 miles. In process of construction, 31.3 miles. Surveyed or under survey, 438 miles. Projects of some promise, 255 miles.

Washington.—Existing Roads.

12. Bellingham Bay & British Columbia.—Track laid in 1891, Everson to Sumas, 7.4 miles.

Bellingham Bay & Eastern.—Track laid since Jan. 1, 1892, New Whatcom to Lake Whatcom, 3 miles. Surveyed, Elk St., New Whatcom, to Lake Junc., 3 miles.

Columbia & Puget Sound.—Graded, Maple Valley to Denny clay beds, 6 miles.

13. Ellensburg & Northeastern.—Partly graded, Ellensburg east, 10.5 miles. Pres., Geo. W. Elliott, Ellensburg.

14. Everett & Monte Christo.—Track laid since Jan. 1, 1892, Lowell to Seattle & Montana R. R., 5 miles; Hartford Junc. to Stillaguamish Canyon, 10 miles. Under construction, Stillaguamish Canyon to Monte Christo, 32.5 miles. Ch. Engr., S. B. Fisher, Snohomish.

4. Great Northern.—Track laid in 1891, Sedro Junc. to Fairhaven, 5.8 miles; Seattle to Fairhaven & Southern R. R., 78.5 miles. Track laid since Jan. 1, 1892, Idaho line to Everett, 352.9 miles.

5. Northern Pacific.—Track laid in 1891, Seattle Belt Line, 10.2 miles; 25.6 miles west of Centralia to Elma, 6.9 miles; Montesano to Ocosta, 24.5 miles; Olympia to Gate City, 21.4 miles; extension Seattle, Lake Shore & Eastern R. R. to Sumas, 23 miles; South Aberdeen to Cosmopolis, 1.6 miles; Chehalis to Pe Ell, 20 miles. Track laid since Jan. 1, 1892, Pe Ell toward South Bend, 21.2 miles. Under construction, to South Bend, 17.3 miles. Partly graded, Gould to Niblocks, 10.2 miles. Surveyed, Sallal Prairie to Denny Mines, 12 miles. Projected, Chehalis to Yakima, 125 miles.

15. Port Townsend Southern.—Track laid in 1891, Olympia to Butler's Cove, 2.7 miles; Hooker's Lake to Quilicene, 7.5 miles. Projected, Quilicene to Butler's Cove, 60 miles.

16. Puget Sound & Pacific Ocean.—Graded, Shelton to Kamiche, 12 miles.

Seattle & Northern.—Track laid in 1891, extension to Hamilton, 6 miles.

14. Snohomish, Skyhomish & Spokane.—Track laid in 1891, Snohomish, Skyhomish & Spokane.—Track laid

17. Spokane Falls & Northern.—Track laid since Jan. 1, 1892, Little Dalles to Northport, 3.5 miles. Surveyed, extension to International line, 10 miles. Projected, Marcus to Lake Osoyoos, 100 miles.

18. Union Pacific.—Portland & Puget Sound R. R.—Partly graded, Portland, Ore., to Seattle, 185 miles.

19. Vancouver, Klickitat & Yakima.—Projected, extension northeast, 10 miles.

Projects and Surveys.

20. Port Angeles Central.—Surveyed, Port Angeles south, 80 miles.

21. Port Angeles Southern.—Surveyed, Port Angeles to Junction City, 35 miles. Ch. Engr., A. J. Blanchard, Port Angeles.

Port Gardner, Lake Stevens & Eastern.—Projected, Everett to Lake Stevens, 5 miles. John F. Hart, Everett.

22. Seattle, Sidney & Gray's Harbor.—Projected, Sidney to Gray's Harbor, 80 miles.

23. Tacoma & Northeastern.—Projected, Tacoma to Port Angeles, with branch to Port Townsend, 115 miles. Pres., Frank C. Ross, Tacoma. Engrs., Ogden & Bosworth, Tacoma.

24. Yakima & Sunnyside.—Projected, Prosser to North Yakima, 50 miles.

Total.—Track laid in 1891, 141 miles. Track laid since Jan. 1, 1892, 395.6 miles. In process of construction, 272.5 miles. Surveyed or under survey, 140 miles. Projects of some promise, 545 miles.

Oregon.—Existing Roads.

25. Astoria & Portland.—Partly graded, Astoria south, 17 miles. Surveyed, to Portland, 113 miles. Pres., John C. Sheehan, New York city. Ch. Engr., Geo. Goss, Astoria.

26. Coos Bay, Roseburg & Eastern.—Track laid in 1891, Marshfield to Dunham's, 10 miles. Track laid since Jan. 1, 1892, Dunham's to Coquille City, 7.5 miles. Surveyed, Coquille City to Roseburg, 72 miles. Secy., W. E. Baines, Marshfield.

27. Oregonian.—Track laid in 1891, Coburg to Natron, 13 miles.

Portland & Mt. Scott.—Track laid since Jan. 1, 1892, Mt. Tabor southeast, 4 miles.

28. Rogue River Valley.—Projected, Medford northeast, 17 miles.

29. Sumter Valley.—Track laid in 1891, Baker City to McEwen, 25 miles.

Projects and Surveys.

30. Albany & Astoria.—Surveyed, Albany to Astoria, 173 miles. Pres., J. L. Cowan; Ch. Engr., W. B. Barr; both of Albany.

31. Columbia River & Astoria.—Surveyed, Astoria to Goble, 60 miles. Pres., J. H. Smith; Ch. Engr., W. H. Kennedy; both of Portland.

32. Siuslaw & Eastern.—Located, Florence to Eugene, 80 miles. Pres., Geo. H. Elisbury; Ch. Engr., T. R. Berry; both of Eugene.

Total.—Track laid in 1891, 65 miles. Track laid since Jan. 1, 1892, 11.5 miles. Surveyed or under survey, 498 miles. Projects of some promise, 17 miles.

California.—Existing Roads.

Arcata & Mad River.—Track laid since Jan. 1, 1892, Riverside to Mad River, 2.5 miles.

33. Atlantic & Pacific.—Projected, Mojave to San Francisco, 400 miles.

34. California & Nevada.—Located, Bryant to Walnut Creek, 12.5 miles.

35. Los Angeles Terminal.—Track laid in 1891, Los Angeles to San Pedro, 27 miles. Surveyed, Glendale to Chattsworth, 25 miles. Ch. Engr., W. F. McClure, Los Angeles.

36. Nevada-California-Oregon.—Surveyed, Amedee to Pitt River, Modore Co., 80 miles. Gen. Man., Erasmus Gest, Reno, Mo.

37. San Francisco & North Pacific.—Track laid in 1891, Guerneville west, 1.34 miles. Track laid since Jan. 1, 1892, 1.97 miles west of Guerneville to 3.9 miles west of Guerneville, 1.93 miles.

San Francisco Belt.—Track laid in 1891, at San Francisco, 0.7 mile. Track laid since Jan. 1, 1892, at San Francisco, 1 mile.

39. San Joaquin Valley.—Track laid in 1891, Fresno to Pollasky, 24.5 miles.

38. Southern California.—Track laid in 1891, Asylum to Acntone, 6.7 miles. Track laid since Jan. 1, 1892, Mesmer to Santa Monica, 5.5 miles.

39. Southern Pacific.—Track laid in 1891, Firbaugh to Armona, 62.3 miles; Avon to San Ramon, 19.7 miles; Crafton toward Redlands, 1.6 miles. Track laid since Jan. 1, 1892, Collis to Fresno, 14 miles; Bakersfield to Asphalto, 49.9 miles. Extension to Redlands, 5.5 miles. Under construction, Santa Margarita to San Luis Obispo, 16 miles. Surveyed, San Luis Obispo to Elwood, 112 miles. Projected, Montpelier to Yosemite Valley, 75 miles; Milton to Calaveras Big Tree, with branch Altaville to Valley Springs, 55 miles; Pollasky to headwaters of the San Joaquin River, 55 miles; San Francisco to San Bruno, 15 miles; King's City to Cariaso Plains, 56 miles; San Luis Obispo to Santa Ynez River, 80 miles; Ventura to Los Angeles, 70 miles; Ontario to Elsinore, 51 miles; San Bernardino to South Riverside, 28 miles; Redlands Junc. to Yucaipa Valley, 15 miles; San Bernardino to Motor Junc., 8 miles.

Projects and Surveys.

40. California Midland.—Projected, Stockton to Visalia, 100 miles. Ch. Engr., Emery Oliver, San Francisco.

41. Northeastern California.—Projected, Castle Crag northeast, 30 miles. J. J. Bowen; A. M. Willis; both of San Francisco.

San Francisco & Atlantic.—Projected, San Francisco to Los Angeles, 300 miles. Fredrick Homer, San Francisco. (Not on the map.)

San Francisco & Clear Lake.—Projected, San Francisco Bay to north line of Lake Co., 125 miles. Treas., J. W. Eisenhuth, San Francisco.

San Francisco & Eastern.—Projected, San Francisco to Rogers, 380 miles. J. R. Howell, San Francisco. (Not on the map.)

San Francisco & Salt Lake.—Projected, San Francisco to Salt Lake City, Utah, 750 miles. Elvin Z. Hayward, San Francisco. (Not on the map.)

43. San Francisco & Santa Clara Valley.—Surveyed, San Francisco to Gilroy, 80 miles. Vice-Pres., Wm. R. R. Johnson, San Francisco.

44. San Luis & San Joaquin.—Projected, Port Harford to Bakersfield, 291 miles. Pres., John M. Wise; Ch. Engr., M. M. Shaughnessy, both of San Francisco.

Total.—Track laid in 1891, 144 miles. Track laid since Jan. 1, 1892, 80 miles. Surveyed and under survey, 307 miles. Projects of some promise, 2,883 miles.

Nevada.—Existing Roads.

Bucksport & Elk River.—Graded, branch up Elk River, 4 miles. Ch. Engr., F. E. Herrick, Eureka.

Utah.—Existing Roads.

45. Great Salt Lake & Hot Springs.—Track laid in 1891, Salt Lake City to Centerville, 11.9 miles. Graded, Bountiful to Hot Springs, 6 miles.

46. Rio Grande Western.—Track laid in 1891, Manti to Salina, 26 miles; Springville to Eureka, 40 miles. Track laid since Jan. 1, 1892, Eureka to Silver City, 4 miles. Projected, Salina to Marysville, 55 miles.

47. Saltair.—Projected, Salt Lake City to Saltair, 15 miles. Ch. Engr., C. W. Hardy; Gen. Man., N. C. Clayton; both of Salt Lake City.

48. Union Pacific.—Partly graded, Milford to Ploche, Nev., 137 miles.

Projects and Surveys.

49. Corinne, Malad Valley & Northern.—Projected, Corinne to Malad City, 45 miles. Ch. Engr., Chas. Nicolet, Corinne.

50. Great Western.—Projected, Salt Lake City to Deep Creek, 150 miles. Pres., J. H. Bacon; Vice-Pres., Walter Jones; both of Salt Lake City.

51. Salt Lake & Ogden.—Projected, Salt Lake City to Ogden, 52 miles. Wm. Fuller, Salt Lake City.

52. Salt Lake & Wyoming.—Projected, Ogden to the Wyoming line, 113 miles. L. G. Wilkerson; C. K. Bannister; both of Ogden.

53. Seattle, Boise City & Salt Lake.—Projected, Salt Lake City to Boise City, Idaho, 325 miles. Pres., J. E. Fulton; Secy., M. L. Sproat; both of Payette, Idaho.

54. Utah & Wyoming.—Surveyed, Garfield Beach to Evanston, Wyo., 126 miles. Pres., B. I. Raybould; Ch. Engr., John B. Taylor; both of Salt Lake City.

Total.—Track laid in 1891, 77.9 miles. Track laid since Jan. 1, 1892, 4 miles. In process of construction, 76 miles. Surveyed and under survey, 126 miles. Projects of some promise, 550 miles.

Colorado.—Existing Roads.

55. Colorado Midland.—Under construction, Hayden Divide to Cripple Creek, 21 miles.

56. Crystal River.—Under construction, Carbondale to Crystal, 35 miles; branches, Coal Junc. to Coal Basin, 12 miles; Marble Junc. to Marble Basin, 3 miles. Gen. Man., J. A. Kebler, Denver.

57. Denver & Rio Grande.—Track laid in 1891, Wagon Wheel Fap to Creede, 9.59 miles. Surveyed, Crested Butte to Irwin, 9 miles.

58. Denver, Lakewood & Golden.—Track laid in 1891, Denver to Golden, 12.5 miles. Located, Golden to Ralston Creek, 6 miles; Golden to Lookout Mt., 10 miles.

59. Rio Grande Southern.—Track laid in 1891, Vance Junc. to Porter's Mill, 121 miles; Telluride to Pandora, 2.25 miles. Track laid since Jan. 1, 1892, branch to Porter's mine, 0.75 mile; branch to the Ute Coal & Coke Co.'s mine, 2 miles. Under construction, branch from Rioc, 3.5 miles. Surveyed, Muncos to Utah line, 55 miles.

48. Union Pacific.—Track laid since Jan. 1, 1892, Victor Junc. to Aquila, 9.82 miles; extension Gray Creek branch, 1.92 miles. Under construction, extension Gray Creek branch, 0.35 miles.

Projects and Surveys.

60. Canyon City & Cripple Creek.—Surveyed, Canyon City to Cripple Creek, 28 miles. Eben Smith, Leadville.

Colorado & Northeastern.—Located, Pueblo east, 120 miles. Projected, to Kit Carson, 100 miles. Pres., O. K. P. Baxter; Ch. Engr., H. R. Holbrook; both of Pueblo.

61. Florence, Cripple Creek & State Line.—Surveyed, Florence to Cripple Creek, 35 miles. Pres., W. E. Johnson, Denver; Gen. Man., J. A. McCandless, Florence.

62. Greeley, St. Vain & Denver.—Projected, Greeley to Idaho Creek, 28 miles. Ch. Engr., John S. Titcomb, Denver.

63. Pueblo, Wet Mt. Valley & Western.—Surveyed, Pueblo to Silver City, 71 miles. Pres., J. C. Teller; Ch. Engr., A. N. Miller; both of Denver.

64. Trinidad, San Luis Valley & Pacific.—Surveyed, Trinidad to Costilo Pass, N. Mex., 60 miles. Ch. Engr., C. H. Knickerbacher, Trinidad.

Total.—Track laid in 1891, 145 miles. Track laid since Jan. 1, 1892, 15 miles. In process of construction, 75 miles. Surveyed or under survey, 381 miles. Projects of some promise, 158 miles.

New Mexico.—Existing Roads.

33. Atchison, Topeka & Santa Fe.—Track laid since Jan. 1, 1892, Waldo to coal mines, 5.75 miles.

65. Kansas City, El Paso & Mexican.—Surveyed, Lanora, Tex., to White Oaks, 148 miles.

66. Santa Fe Southern.—Surveyed, Santa Fe to San Pedro, 49 miles.

67. Silver City & Northern.—Track laid in 1891, Whitewater to Hanover, 18 miles.

48. Union Pacific.—Track laid since Jan. 1, 1892, extension of the Red River branch, 0.1 mile. Projected, extension Red River branch, 10 miles.

Projects and Surveys.

68. Albuquerque, Colorado & Salt Lake.—Projected, Albuquerque to Durango, Colo., 160 miles. Geo. L. Brooks, Albuquerque.

69. Deming & Utah Valley.—Projected, Deming to Gallup, 293 miles. Pres., Frank H. Siebold; Ch. Engr., D. A. R. McLaren; both of Deming.

70. Denver & El Paso Short Line.—Projected, Trinidad, Colo., to El Paso, Tex., 400 miles. Gen. Man., O. M. Houghton, Las Vegas.

Total.—Track laid in 1891, 18 miles. Track laid since Jan. 1, 1892, 6 miles. Surveyed or under survey, 200 miles. Projects of some promise, 843 miles.

Arizona.—Existing Roads.

86. Marcopia & Phoenix.—Projected, Tempe to Mesa City, 8 miles.

87. Santa Fe, Prescott & Phoenix.—Graded, Ash Fork south, 50 miles; 15 miles of track laid. Under construction, extension to Phoenix, 150 miles.

88. Southern Pacific.—Surveyed, Phoenix to Prescott, 100 miles.

Texas.—Existing Roads.

(Lines within limits of map only.)

71. Austin & Northwestern.—Track laid since Jan. 1, 1892, Fairland to Llano, 29.4 miles.

72. Chicago, Rock Island & Pacific.—Under construction, Red River to Bowie, 24 miles. Under survey, Bowie to Ft. Worth, 65 miles.

73. Ft. Worth & Rio Grande.—Track laid in 1891, Comanche to Brownwood, 33.5 miles; at Ft. Worth, 2.5 miles. Projected, Brownwood to Brady, 44 miles.

74. Georgetown & Granger.—Partly graded, Georgetown to Granger, 15 miles.

75. Hearne & Brazos Valley.—Track laid in 1891, Hearne & Brazos Valley to Mumford, 9 miles. Track laid since Jan. 1, 1892, Mumford to Moseley's Ferry, 5.3 miles.

Houston Belt & Magnolia Park.—Projected, extension to Harrisburg, 3 miles.

76. La Porte, Houston & Northern.—Under construction, La Porte to Houston, 22 miles. Ch. Engr., C. I. Woodbury, La Porte.

77. Missouri, Kansas & Texas.—Track laid in 1891, Milford to Hillsboro, 14.8 miles; Lexington to Lott,

57.9 miles. Track laid since Jan. 1, 1892, Smithville to Lockhart, 36 miles; Boggy Tank to Sealy, 27 miles. Under survey, Sealy to Houston, 50 miles.

78. North Galveston, Houston & Kansas City.—Under construction, North Galveston to Virginia Point, 16 miles. Projected, North Galveston to Beaumont, 75 miles.

79. Pan American.—Track laid since Jan. 1, 1892. Victoria to Guadaloupe River, 10 miles. Located, Guadaloupe River to Refugio, 39 miles. Surveyed, Refugio to Brownsville, 181 miles. Ch. Engr., Wm. H. Baker, Victoria.

80. Texas Central.—Surveyed, Dublin to Thurber, 32 miles.

81. Texas, Louisiana & Eastern.—Track laid in 1891, Conroe east, 8 miles. Under construction, extension to Ironwood, 32 miles.

82. Velasco Terminal.—Track laid in 1891, Velasco to Oyster Creek, 6 miles. Track laid since Jan. 1, 1892, Oyster Creek to Chenango Junc., 15 miles; Velasco to Surfside, 3.5 miles.

Projects and Surveys.

83. Gulf, Newport & Northern.—Projected, Alligator Head to San Antonio, 150 miles. Construction rumored in progress on 20 miles. Thos. M. O'Connor, Victoria.

Houston Belt.—Located, belt line at Houston, Tex., 18 miles. Gen. Man., Thos. Nichols, Houston.

Rockport & Harbor Island.—Surveyed, Rockport to Harbor Island, 10 miles. Pres., John H. Traylor, Dallas.

84. Trinity, Cameron & Western.—Surveyed, Trinity to Granger, 113 miles. Pres., J. M. Hefly, Trinity.

85. Velasco Northern.—Surveyed, Velasco to Rosenberg, Junc., 60 miles.

Total.—Track laid in 1891, 161 miles. Track laid since Jan. 1, 1892, 97 miles. In process of construction, 100 miles. Surveyed or under survey, 572 miles. Projects of some promise, 282 miles.

Mexico.—Existing Roads.

British Mexican.—Graded, Jiminez northeast, 25 miles. Surveyed, extension to Sierra Mojada, 155 miles. Ch. Engr., John E. Earley, Jiminez.

Cerro Blanco.—Nearly completed, Cerro Blanco to mines in Sierra Mojada Mts., 17 miles.

Hidalgo.—Under construction, Las Lojas to Tuxpam, 100 miles.

Interoceanic.—Projected, Matamoras de Izucan to Acapulco, 130 miles; Santa Barbara to San Martin, 41 miles; San Juan to Tezintla, 40 miles; Soapayuca to Pachuca, 32 miles; Huaticaco to Cuernavaca, 40 miles; Antigua to Huatusco, 47.5 miles.

Lower California.—Graded, San Quintin northeast, 20 miles. Surveyed, extension to Tiajuana, 155 miles. Ch. Engr., W. Z. Earle, San Diego, Cal.

Matamoras & Matehuala.—Surveyed, Matamoras to Linares, 165 miles.

Mexican Central.—Surveyed, Guadalajara to 16 miles east of San Blas, 150 miles.

Mexican International.—Track laid since Jan. 1, 1892, Pedricena to Valerdena, 6 miles; Torreon to Durango, 158 miles. Projected, Durango to Mazatlan, 125 miles. Under construction, Monclova toward Sierra Mojada, 155 miles.

Mexican Mineral.—Under construction, Palmajero to Zapote.

Mexican National Construction.—Surveyed, Colima to Guadalajara, 166 miles. A small amount of grading done near Colima.

Mexican Northern Pacific.—Surveyed, Deming, N. Mex., to Guerrero, 225 miles; Guerrero to Chihuahua, 120 miles. Projected, Guerrero to Topolobampo and Guaymas, 850 miles. About 20 miles have been graded south of Deming. Res. Engr., Wm. Martineau, Deming.

Mexican Pacific.—Surveyed, extension to Frontera, 380 miles.

Mexican Southern.—Track laid since Jan. 1, 1892, between Tecomovaca to Oaxaca, 70 miles. Surveyed, Oaxaca to Tehuantepec, 175 miles.

Mexico, Cuernavaca & Pacific.—Surveyed, City of Mexico to Pacific coast, 300 miles. Construction in progress near City of Mexico. Pres., Geo. Tritch, 11 Bank Block, Denver, Colo. Ch. Engr., John L. Butman, City of Mexico.

Monterey & Mexican Gulf.—Projected, Trevino to Sierra Mojada, 175 miles.

National Tehuantepec.—Track laid in 1892, 17 miles. Under construction, 69 miles.

Venegas, Cedral & Rio Verge,—Projected, Catorce to Rio Verde, 160 miles.

Projects and Surveys.

Apam & Cazones.—Projected, Apam to Cazones, 100 miles.

Chihuahua Eastern.—Projected, Sierra Mojada to Laguna del Norte, 70 miles.

Chiapas.—Projected, Chiapas to Teapa, 15 miles.

Durango & Zacates.—Projected, Durango to Zacates, 200 miles.

Guadalajara Belt.—Projected, belt line from Guadalajara to Zapopam, Ameca and return.

International.—Projected, Matamoras to Guatemala, 900 miles.

Mexican Western.—Projected, Topolobampo to Presidio del Norte, 900 miles.

Mexico & Zihuatanejo.—Projected, City of Mexico to Zihuatanejo, 300 miles.

Oaxaca Coal.—Projected, Pueblo to the Rio Verde, 175 miles.

Total.—Track laid since Jan. 1, 1892, 245 miles. In process of construction, 386 miles. Surveyed or under survey, 2,021 miles. Projects of some promise, 4,175 miles.

The Hudson River Tunnel Railway Co. is being sued for $28,550 by S. Pearson & Son, of London, England, for work done on the tunnel since 1889. The case is to come to trial this month.

UNDERGROUND WIRING ON ELECTRIC STREET RAILWAYS.

There has been some discussion recently concerning the effect of the ground current of electric street railways in corroding water pipes adjacent to the line. (Eng. News, Sept. 22, 1892). At the recent convention of the American Street Railway Association, something was said on this point in the discussion of the report on "A Model Electric Railway Roadbed and Underground Wiring," published in our issue of Oct. 27; but it was withheld from publication at the time. This action has since been reconsidered. We condense as follows the remarks made by Mr. Pearson, Electrician of the West End Street Ry., of Boston:

In small systems where there are few cars running, the ordinary method of returning the current through the rails and supplementary wire will be sufficient unless the distance is great. But on large roads where the traffic is heavy more return grounds than have been used heretofore will have to be installed. We found it so in Boston, and from a lack of return feeders a great deal of electrolytic action was caused in our supplementary wire. We are now putting up a large amount of overhead copper for return grounds; I do not think it possible to put it underground, as it will corrode and rust away. There is no advantage in using iron, as the conductivity is only one-seventh that of copper.

Originally we ran the positive current through the trolley wire, but we found that the action on the supplementary wires was too great, and we changed it and put the negative through the trolley wire. I do not imagine there will be much less effect, as it merely transfers the action to another point.

Mr. Pearson: I do not recall any particular trouble with water pipes; but naturally, if you have a large volume of current going through the earth, it will take hold of a water pipe or a gas pipe, or any other pipe, and there will be an electrolytic action set up. In any large railway system, if the attempt is made to use the earth for return ground by putting in ground plates in driven wells, or by putting them in the rivers, and the return current is not provided with a good metallic circuit, it seems to me that the current must inevitably injure the water pipes and all other pipes. The current when it leaves the car goes into the ground and taking a water pipe may go a mile on that pipe, then leave it for a better conductor; the result being that the pipe will be corroded at this latter point.

(In reply to the suggestion that old rails might be put in the ground to carry the return current:)

The difficulty in using old rails for the return current would be to make a joint. If you could weld the rails together or if you could solder them, I think possibly it would work; but I do not believe you could make the joints in any other way that would carry a large volume of current without heating and corrosion.

(Replying to the suggestion that the joint be made with copper plates:)

Iron and copper would form an electrolytic element, and cause corrosion even if no current were passed through the joint. The passage of the current would also heat the joint and cause further oxidation. We attempted, in the early days of electric railroading, to use the rail for the return conductor, not putting in supplementary wires, and found it almost impossible to maintain a joint of any sort. Where you drive a large volume of current through the joint, oxidation takes place, and the joint soon becomes worthless. This condition will exist no matter how large the joint is made, and if you use dissimilar materials or metals, a local electrolytic action will also take place. With steel in contact with iron, the effect will be produced in a lesser degree than with copper, and it will take longer for the trouble to develop. It does not seem to me practicable to use old rails for conductors.

(In reply to the suggestion that worn out cables from cable roads, weighing 2 lbs. per ft., and costing about $50 per mile, would make good return circuits):

We used considerable old steel and iron cable, in getting across the rivers and connecting our supplementary wires from one side of the track to the other, but it cuts away very fast. For instance, in one place we put in seven ropes or cables, and soldered the joints thoroughly at each end, and in less than four months they were entirely gone. If you had soil which was comparatively dry and sandy, it might do for a time. In a place where the soil was moist and salty, I doubt whether you would get enough life out of it to pay for putting it doyn.

Mr. F. S. Holmes, of New York, said: In an ordinary battery, the positive pole is the pole that gives and is consumed, and the negative pole is the pole that receives deposit. The construction we have to-day where ground plates are used for return currents makes the trolley wire and the various plates and supplementary wires along the line of the railroad positive, and the large ground plate at the station negative. This is wrong, because, where this is done the supplementary wire and ground plates along the line are rapidly corroded and eaten away, while the negative plate at the station is uninjured. The conditions should be reversed, the station plate being made positive and the line plates and supplementary wire and trolley negative to it. Corrosion will thus be largely confined to the station plate, which can be easily replaced, and the plates and supplementary wire along the road will remain nearly intact. Of course, to accomplish this the current will flow out by the ground, which will be positive, and back by the trolley wire, which will be negative.

The introduction of the block system on the New York Central is making rapid progress, and trains are now run under protection of the blocks from New York city to Hudson, 114 miles, and the signal towers and bridges are completed for the remainder of the distance to Albany, 29 miles. West of Albany the bridges are completed all the way to Buffalo, and the towers are framed as far west as Utica. It is expected that the system will be in full operation to Utica, 238 miles from New York, by Christmas. When the system is complete there will be 205 block stations between New York and Buffalo, making the average length of the blocks about 2 1-5 miles. Of course, the blocks are made shorter near the important stations, so that the average length on the open road is about three miles. The semaphore signals at the block stations are carried on overhead trusses of 56-ft. span, with a clear headway beneath them of 21 ft. The block stations are connected by an 8-wire Kerite cable suspended on poles.

The land grant system for the construction of railways in the Australian colonies seems to be gaining ground. Queensland has just decided to follow the example of Western Australia in this direction, and in the New South Wales assembly a motion has been brought forward for the construction of lines of railway from Bairnsdale, in Gippsland, to the New South Wales border, and also for connecting the irrigation settlement at Mildura with the railway system of the colony on the land grant system. Mr. Wheeler, the Minister of Railways, stated during the discussion that if they could not obtain funds for constructing necessary lines by the usual method of raising loans on the London market, they must have recourse to the state lands to provide the needful funds. It was essential to the development of the colony to extend the railways, and if the state could not find the money, they must resort to private enterprise to do the work, and pay those who built the lines in land. The general feeling of the House seemed to be in favor of the motion.

Telegraphic communication between trains and stations was one of the subjects considered at the recent International Railway Congress held in St. Petersburg. The Great Northern Ry. Co., of England, is considering the advisability of trying an interesting experiment in this direction. A number of the officials of the company have been to Paris recently to inspect the model of a new system by which passengers in a moving train are able to communicate by telegraph and telephone with the various stations. This invention will not only enable passengers to transact business during a journey, but will also afford facilities for the engineman and conductor to communicate with the signalmen.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

QUEBEC, MONTMORENCY & CHARLEVOIX.—Ch. Engr., E. A. Hoare, Quebec, P. Q., writes us that eight miles have been graded on the extension from Ste. Anne de Beaupre to Murray May, P. Q., 38 miles. This eight miles takes the extension to Cape Tourmente. Two miles of track were laid in October and the remainder is to be laid early in 1893, when construction will also be resumed on the remainder of the extension. The route of the extension is along the north shore of the St. Lawrence River. Mr. Hoare also states that the Quebec & Lake St. John Ry. is building a branch from Chambord Junc., near Lake St. John, to Chicoutimi, P. Q., on the Saguenay River.

PORTLAND & RUMFORD FALLS.—The contract for building the extension from Mechanic Falls, Me., to a connection with the Maine Central R. R., at a point about two miles from Danville Junc., 11¼ miles, has been let to John Berry, Fayville, Mass. The route is by the way of Poland Springs. The work is to begin at once and the line completed by Sept. 1, 1893. Ch. Engr., Frederic Danforth, Mechanic Falls, Me.

PENNSYLVANIA.—The engineers of this company have completed the surveys for three lines from Bustleton, Pa., to a connection with the New York division beyond Bristol, Pa. Two of these strike the New York division near Tullytown, Pa., and the third connects with the Trenton cut-off near Fallington, Pa. Estimates of the comparative costs of the three lines will be made and the work of construction begun in the spring.

LAKE SHORE & MICHIGAN SOUTHERN.—The Silver Creek & Dunkirk Ry. was opened for all L. S. & M. S. trains Nov. 20, 1892. The construction of this line was begun early in 1891. The line is double track,

with maximum grade of 15.8 ft. per mile, used only in one place, and curves of 0° 40'. Its length is 8.8 miles, and only 133 ft. shorter than the old route, but it saves 21° in curvature, and reduces grades of 30 ft. per mile to 15.8 ft. per mile. Over 500,000 cu. yds. of excavation, much of which was rock, and 5,000 cu. yds. of arch masonry and 2,000 cu. yds. of other masonry structures were required in its construction. The contractor was The Drake & Stratton Co., of New York city.

BALTIMORE & OHIO.—In addition to the extension of the Staten Island Rapid Transit R. R., noted last week, this company has extensive terminals under construction on Staten Island. Among these is a large station, bids for the construction of which have already been received. The building will be of iron, 100 ft. wide and 150 ft. deep, and will cost about $150,000. It will be located on the great pier now nearing completion, which is 2,000 ft. wide and 1,300 ft. deep. Back of the pier a yard will be laid out with a trackage capacity for 1,000 cars, and supplied with the interlocking switch system. Among other improvements to be made on the Island are the erection of two large freight warehouses at St. George, each 75 ft. by 100 ft.; four ocean steamship piers, each 100 by 700 ft., with slips 50 ft. wide, at Tompkinsville; new shops and a large freight yard near the Arthur Kill bridge, and a shipyard at Clifton. These improvements will require an expenditure of about $1,000,000.

NEW YORK & NEW ENGLAND.—There is talk of extending the Meriden, Waterbury & Connecticut River R. R. from Meriden to Middletown, Conn. An official is reported as saying that no time had been set for building the extension, but that it would probably be done in the near future.

PLYMOUTH & MIDDLEBORO.—This road recently completed, from Plymouth to Middleboro, Mass., 16 miles, has been opened for traffic. It is to be operated by the Old Colony R. R. Co., for 65% of the gross earnings.

LANCASTER, OXFORD & SOUTHERN.—Work on the construction of this line is progressing well according to the local papers. The line consists of two sections joining the main line at Kings Bridge and Oxford, Pa., and running to Quarryville, Pa., and Singerly, Md., respectively.

BALTIMORE & OHIO.—A Pittsburg, Pa., press dispatch, dated Dec. 2, says: "Probably one of the biggest deals in the railroad business of Pittsburg that has occurred for years has been slowly crystallizing for the past two months. It is the introduction of a terminal for two new roads into the city. Representatives of the Philadelphia & Reading and Wabash roads, with Baltimore & Ohio officials, have been coming and going for some time, and it appears that they have been purchasing options all along the South Side, from Munhall to the city limits. The intention appears to be to cross the river over the new bridge at Beck's Run, and come in over the tracks of the Baltimore & Ohio, by an agreement already entered into with that company. The terminal facilities are already provided for by the securing of a large tract at Second Ave. and Try St., and a large property close by on Second Ave., the site of the old Kensington mill."

OHIO SOUTHERN.—Sub-contracts will be let at once for 60 miles of the Springfield-Lima extension by McArthur Bros., Temple Building, Chicago, Ill. Maximum grade 26 ft. per mile and maximum curve 2°.

BEDFORD, BELT.—Eleven miles of this belt railway at Bedford, Ind., are completed and contracts will soon be let for an extension four miles long. Gen. Man., T. J. McGuire, Bedford, Ind.; Ch. Engr., Jas. K. Zallinger, Louisville, Ky.

Projects and Surveys.

NEW YORK STATE.—The appearance of a corps of surveyors working along the west branch of the Delaware River has given rise to various rumors concerning a projected extension of the West Shore R. R. to the Pennsylvania coal fields.

INDIANAPOLIS & SOUTHWESTERN.—Chartered in Indiana to build a railway from Indianapolis, Ind., to East St. Louis, Ill. The principal office will be at Chicago, Ill., and the incoprators are: L. W. Downey, Gosport, Ind., J. M. Jones, Cataract Falls, Ind., and W. A. Wallace and Geo. A. Crosby, of Chicago.

PHILADELPHIA & WILLISTOWN.—Chartered in Pennsylvania to build a railway from Philadelphia, Pa., through Delaware Co. to a point near the Spread Eagle Hotel, Haverford township: Among the incorporators are: J. G. Allen, J. C. Sharpless and John C. Keys; all of Philadelphia, Pa.

Southern.—Existing Roads.

WEST VIRGINIA, PINEVILLE & TENNESSEE.—Gen. Man. J. D. Blake, Pineville, Ky., writes the "Manufacturers' Record" that this company is grading a small portion of its road southward from Pineville, Ky., and expects to construct within the next few weeks an extension of about a mile up the right fork of Straight Creek to accommodate the coal operations now commencing there. The company will build eight or ten miles more next season up the left fork of Straight Creek to afford facilities to the coal and lumber operations in that direction.

PICKENS.—This 9½-mile line from Easley to Pickens, S. C., is now graded ready for the rails: The company wants 500 tons of second-hand 35-lb. or 40-lb. steel rails and fastenings, and a second-hand 26 or 30-ton locomotive. J. H. Burkhalter, Augusta, Ga.

LOUISVILLE, ST. LOUIS & TEXAS.—Work is being rapidly pushed ahead on the extension from West Point to South Park, Ky: The principal contractors, Ferguson & Dreisbach, have advertised for 100 men and 50 teams, and announce their intention to work all winter.

MACON & ATLANTIC.—This Georgia railway has been purchased at auction by a syndicate of the creditors and bondholders of the road for $410,000: This line was projected to run from Sofkee, Ga., near Macon, Ga., east to Savannah, Ga., and Gaieton, S. C., 200 miles. In 1890 11½ miles of the road from Benton, Ga., east were completed and about 75 miles additional were partly graded. In March, 1891, the Macon Construction Co., which was building the line, failed, and in November of the same year, a receiver was appointed. It is stated that the purchasers of the road will organize at once and complete the line as projected.

FLORIDA CENTRAL & PENINSULAR.—The contract for building the line from Hart's Road, Fla., to Savannah, Ga., has been awarded to the New York Construction Co. The contract provides for 70-lb. steel rails and steel bridges, and the completion of the work by Sept. 1, 1893.

GURLEY'S & PAINT ROCK VALLEY.—It is announced that work will soon be resumed on this Alabama railway. Ch. Engr., Samuel I. Wheatcroft, Gurley's, Ala.

BIRMINGHAM, LANEY & PIEDMONT.—It is expected that the extension from Laney, Ala., to the Burke Iron Mt., 8 miles, will be built in January, 1893. Ch. Engr., P. S. Fitzgerald, Gadsden, Ala.

Projects and Surveys.

KANAWHA & BUCKHANNON RIVER.—Chartered in West Virginia to build a railway from Lanes' Station, Upshur Co., W. Va., to a point near Cleveland, Webster Co. The incorporators are R. E. McQuay, of Buckhannon, W. Va., and others. The principal office of the company will be at Baltimore, W. Va.

MISSISSIPPI CENTRAL VALLEY.—Arrangements are reported completed for the construction of this railway from Rosedale, Miss., to Bogue Phalia, 6½ miles, and the locating surveys have been commenced. It is intended to have this section completed by April 1, 1893, and then it is expected to take up the work of further extension. Pres., Chas. Scott; Ch. Engr., R. B. Eggleson; both of Rosedale, Miss.

MOBILE TRANSPORTATION CO.—This company proposes to build a belt railway at Mobile, Ala.

ALABAMA & GULF.—A bill has been introduced into the Alabama Legislature chartering this company to build a railway from Montgomery, Ala., to some point on the Florida line, in Geneva or Covington counties. Among the incorporators are: J. F. Dennis, E. A. Graham and H. G. McCall.

MONTGOMERY & SOUTHEASTERN.—A bill has been introduced into the Alabama Legislature chartering this company to build a railway from Montgomery to some point on the Georgia line, in Henry Co.

Northwest.—Existing Roads.

JACKSONVILLE & SOUTHEASTERN.—Ch. Engr. L. S. Olmstead is reported as saying that work on the Havana-Rock Island branch of this railway is making very satisfactory progress. About 90% of the grading has been completed, and the bridge work is well under way.

GREAT NORTHERN.—A press dispatch says: "The Great Northern is likely to build a new branch line. Between Crookston and Duluth via the White Earth reservation and Leech Lake, and engineers and surveyors have been busy all the past week with theodolites and chains. Improvements in this section have been going on rapidly of late, and among many indications of enterprise are the large saw mills erected by Mr. T. B. Walker, of Minneapolis, all of which is in view of the railway communication which is expected very soon. The country covered by the proposed new line is extremely fertile and valuable, and the result will be many thriving industries and towns. One great advantage will be that the detour which the Great Northern now makes from Crookston to the head of the lakes will become a direct line. Later investigation furnishes the information that this line will be an extension of the Fosston branch, and that the Minnesota lands which will be granted will likely be along the White Earth border."

CHICAGO, ST. PAUL, MINNEAPOLIS & OMAHA.—A press dispatch from Sioux City, Ia., states that it is authoritatively announced that the line from Ponca, Neb., to Newcastle, S. Dak., will be built. The contract is said to have been let for the completion of the line by Sept. 15, 1893.

MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE.—Track on the northwestern extension from Valley City, N. Dak., has been laid to Cathay, N. Dak., 80 miles, and work is now discontinued for the winter.

CHICAGO, LAKE SHORE & MICHIGAN SOUTHERN.—Work is reported begun on a railway by this name, from a point on the Chicago & Atlantic R. R., in Indiana, south to a point on the Elgin, Joliet & Eastern and Michigan Central railways.

ELGIN, JOLIET & EASTERN.—The contract is reported let to Hannon & Co., of Chesterton, Ind., for grading the proposed extension from McCool to Porter, Ind.

Projects and Surveys.

ST. PAUL, GALESBURG & SOUTHERN.—Chartered in Illinois to build a railway from a point on the northern boundary of Illinois, in Jo Daviess Co., south to Waverly, Morgan Co., with branches from a point in Fulton Co., to Peoria, Ill., and southwest to a point on the Mississippi River. The principal offices will be at Chicago. Among the incorporators are: A. G. Atherton, Lewiston, Ill.; Wm. M. Van Northwick, Batavia, Ill., and T. M. Stuart, S. H. Mallory, and D. J. Thayer, of Chariton, Ia.

Southwest.—Existing Roads.

GULF, NEWPORT & NORTHERN.—About 3½ miles have been graded on this railway north from Alligator Head, Tex., to Victoria and San Antonio, Tex.

TEXARKANA & FT. SMITH.—It is announced that the completion of this line to Ft. Smith, Ark., is probable. The company has submitted a proposition to the city of Texarkana, Ark., whereby it agrees to complete the road on condition that that city subscribes $40,000 in its aid. The line as projected runs from Texarkana to Ft. Smith, 198 miles, and 28 miles, north from Texarkana, have been completed.

MISSOURI, KANSAS & TEXAS.—Thos. C. Purdy, 2d. Vice-Pres., states that the report that this company is considering the construction of an extension from Coffeyville, Kan., to Vernon, Tex., 300 miles, as noted in our last issue, is a mistake.

CHICAGO, ROCK ISLAND & PACIFIC.—About 9 miles of track have been completed of the 24 miles between the Red River and Bowie, Tex. It is also stated that the contract has been awarded for the division from Bowie to Springtown, Tex.

Rocky Mt. and Pacific.—Existing Roads.

COOS BAY, ROSEBURG & EASTERN.—Work is progressing rapidly on the extension to Coquille City, Ore. About 8 miles of track are now laid south of Dunham, Ore., making a total of 18 miles of line completed south of Marshfield, Ore.

SPOKANE FALLS & NORTHERN.—Contracts have been let for the extension from Northport, Wash., to the International line. The locating surveys for the Nelson & Ft. Sheppard Ry., which is a continuation of this road to Nelson, B. C., are nearly completed, and construction will probably begin in the spring.

EL PASO & NORTHERN.—Surveys have been begun for the extension of this line from Elnora, Tex., to White Oaks, N. Mex.

Projects and Surveys.

COLORADO SOUTHERN.—Chartered in Colorado to build a railway from Texas Creek Station, on the Denver & Rio Grande R. R., to a point midway between Silver Cliff and West Cliff. The officers of the company are: Pres., H. Townsend, Vice-Pres., H. H. Tompkins, and Secy. and Treas., Geo. B. Beardsley.

WYOMING.—A press dispatch from Chicago says: "Ex-Governor Campbell, of Ohio, William Amen, R. J. Deane, Arthur R. Townsend, George Green; all of New York city; John Weir, of Wyoming, and Charles J. Barnes, of Chicago, to-day formed themselves into a company with a capital of $3,000,000, for the development of a vast quantity of property in various portions of Wyoming. The object of the company, as declared by the agreement and the articles of incorporation, is to be to build two railroads to develop the soda lakes which are owned by Mr. Weir, and are producing every kind of soda for which use can be found; the irrigation of 6,000 acres of land, and the opening up of 10,000 acres of coal and 6,000 acres of iron land. One railroad, for which a survey has already been made, will run from Caspar to Hanna, a distance of 129 miles. Its course will be through the valley of the Sweetwater. The other road will run from Johnston to the crossing of the Northern Pacific and the Big Horn River, a distance of 300 miles. The land to be irrigated is contiguous to Johnston. The coal and iron lands are in the Seminole Valley, west of the Platte River. The whole cost involved will be about $12,000,000 at the lowest possible estimate. The smaller railroads will be finished in about a year, and the remaining work will be brought to a termination as speedily as possible."

DENVER & EL PASO SHORT LINE.—The promoters of this proposed railway from Trinidad, Colo., to El Paso, Tex., 400 miles, claim to have interested eastern capitalists in the project, and to have secured the promise of sufficient capital to build the road. They now ask that the towns along the route shall subscribe for $1,000,000 of the preferred stock of the company as an assurance of good faith, and state that the work of construction will begin as soon as this is done. The line opens up a new section of the country containing valuable mineral and other natural resources.

ALBUQUERQUE, COLORADO & SALT LAKE.—It is stated that an expert is now examining the route of this line from Albuquerque, N. Mex., to Durango, Colo., 210 miles, in the interest of eastern capitalists.

PHOENIX, MT. OLIVE & MESA.—Chartered in Arizona to build a railway 25 miles long in the Mesa Valley.

CLEAR LAKE & RUSSIAN RIVER RY. & NAVIGATION CO.—This company proposes to build a railway line, to be operated either by steam or electricity, from Lakeport to Hopeland, Cal., between 20 and 25 miles. The officers of the company are: Pres., F. W. Gibson; Secy., Wm. J. Bigerstaff, and Treas., D. W. White. The headquarters of the company are at Lakeport, Cal.

Foreign.

MEXICAN INTERNATIONAL.—According to recent reports this company will build a branch from Escalon to Monterey, Mex., and surveys will begin at once. Work is now in progress on the line from Monclova to the Sierra Mojada.

MEXICO, CURRUAVACA & PACIFIC.—About 12 miles of this line southwest from the City of Mexico have been completed, and it is expected to have 31 miles completed by Jan. 1, 1893. About that time the first 12 miles will also be put in operation.

ELECTRIC RAILWAYS.

CAMBRIDGE, MASS.—The Cambridge Storage Battery Electric Street Ry. Co. has applied to the Railway Commissioners for a certificate for a charter. The people along the road gave evidence taht they wanted the line, but were opposed to the trolley system.

DRAVOSBURG, PA.—The Dravosburg Electric Ry. Co. has been incorporated to build a line to Reynoldton; capital stock, $15,000, with $3,000 paid in; Pres., John M. Ilisher.

BALTIMORE, MD.—The Baltimore County Commissioners have granted a franchise to the Edmonson Ave., Catonsville & Elliott City Electric Ry. Co. The track and poles are to be on the extreme south side; all sidings are to be on the driveway side of the track, but no sidings are to be placed on the old Frederick road, which is to be macadamized 26 ft. of its width; the construction is to be subject to the Board's supervision; the rails are to be so laid not to obstruct the passage of vehicle or impede the free flow of water; the grade of the tracks is to conform to the present or future grade of the avenue and old Frederick road; the space between tracks and 2 ft. on the outer side is to be kept in repair by the company; all crossings, public and private, are to be maintained so as to afford transit across the tracks; the overhead wires to be protected by guard wires; the sidewalk is to be 15 ft. wide, including the gutter on the south side of the tracks; the work is to begin in six months and to be completed in 18 months; bond of $20,000 is to be given and a fine of $25 a day is to be imposed for obstruction to travel.

NEW ORLEANS, LA.—A syndicate of local and northern capitalists has acquired control of the New Orleans City & Lake Ry. and the Crescent City Ry., and is expected to acquire other lines. Work on construction for electric traction will be commenced soon.

HIGHLAND, COLO.—An engineer has made an estimate on the cost of the proposed electric railway to Golden at $2,000 a mile, or $18,000 exclusive of cars and power plant. Geo. H. Kimball, Col. Daniel Sayer and M. T. Morrill, of Highlands, and George West, of Golden, are interested.

MONTEREY, CAL.—The Monterey & Pacific Grove Street Ry. has been sold to the Carroll-Hopkins Co., of San Francisco, for $75,000, and the road, which is 5 miles long, will be equipped for electric traction.

STOCKTON, CAL.—The California Electric Ry. Co. has been incorporated to build a line for freight and passenger traffic to Lodia and Wallace; capital stock, $1,000,000; incorporators, H. J. Corcoran, I. S. Bostwick and S. D. Woods.

BALLARD, WASH.—A franchise for an electric line on Burke Ave. and Mohr St. to the city limits has been granted to the Consolidated Street Ry. Co. The

company proposes to ask the Seattle City Council for a continuation of this line to a connection with its existing line at Fremont, and will begin construction as soon as this is obtained. The line will be less than a mile long and will require very little grading, as the route is almost level.

HALIFAX, N. S.—The Nova Scotia Power Co. has purchased the entire plant and business of the Halifax Illuminating & Motor Co. for $200,000. Both companies will be amalgamated with the Halifax Street Ry. Co., and the whole concern will be transferred to a Boston syndicate, which will construct an electric road.

HORSE AND MOTOR RAILWAYS.

BRISTOL, PA.—The Bristol & Newtown Street Ry. Co. has been incorporated with a capital stock of $100,000, $20,000 being paid in. Pres., A. C. Milliken, Pottsville, Pa.

DETROIT, MICH.—The Detroit & North Detroit Ry. has been completed and put in operation. M. J. Griffin was contractor for the grading, track-laying and ballasting. The road is five miles long and is laid with 60-lb. steel T rails. The engine is a steam motor manufactured by H. K. Porter & Co., of Pittsburg, Pa.

HIGHWAYS.

MASSACHUSETTS.—The State Highway Commission gave a hearing at Salem, Nov. 26, to County Commissioners on the construction and maintenance of highways.

WYOMING.—E. C. Bartlett, of Miner's Delight, who is Manager of the Diamond Developing Co., and Mr. Evans, of Denver, Colo., both largely interested in mining in South Pass, are at work opening a new wagon road from Point of Rocks on the Union Pacific Ry. direct to Atlantic City and Miner's Delight, which shortens the distance from the railway one-half. The new route reduces the stage time from 33 hours to 12 hours and does away with the steep grade over Beaver hill.

BRIDGES, TUNNELS AND CANALS.

PROVIDENCE, R. I.—The Common Councils has ordered the construction of an iron bridge over Francis St.

BUFFALO, N. Y.—The following bids for a stone arch or steel arch bridge over Scajaquada Creek have been received.

Stone arch:	
W. A. Green, Buffalo	$85,000
Chas. E. Williams	91,190
John Mumm	95,715
Geo. Parks & Sons	117,067
Steel arch:	
Buffalo Bridge & Iron Works	$99,000
Kellog Iron Works	97,200
Geo. Parks & Sons	97,500
Berlin Iron Bridge Co.	97,900
Owego Bridge Co.	100,000
King Bridge Co.	101,000
Penn Bridge Co.	104 0 0
Variety Iron Works	106,700

The bid of W. A. Green for a stone arch will probably be accepted. The bridge will be between 400 and 500 ft. long, 58 ft. wide, and consist of two spans.

NEW YORK CITY.—Bids will be received until Dec. 15 for building a steel bridge in Eagle Ave., crossing Clifton St. Louis J. Heintz, Com. St. Impts.

SARATOGA CO., N. Y.—The Saratoga Co. Board of Supervisors has granted a franchise for a free wagon and railway bridge over the Hudson River at Thomson's Mills.

BIRDSBORO, PA.—The Wilmington & Northern R. R. is preparing plans for an iron bridge across the Schuylkill River at this place.

OMAHA, NEB.—The contract for building the proposed bridge over the Missouri River, between Omaha, Neb., and Council Bluffs, Ia., is reported let to the Milwaukee Bridge & Iron Works, Milwaukee, Wis.

WATER-WORKS.

New England.

PITTSFORD, VT.—Bids for building small works are wanted until Jan. 10; 6 miles 6, 4 and 3-in. pipe; 25,000-gallon covered reservoir; J. M. Goodnough, Pres. Pittsford Aqueduct Co.; Chappell & Burke, Rutland, Engrs.

BOSTON, MASS.—A $2,500,000 4% 50-year loan for the extension and perfection of the water supply is under consideration.

HAVERHILL, MASS.—Bids for $800,000 4% water bonds are wanted until Dec. 20; $375,000 payable in 20 and balance in 30 years. John A. Glines, Cy. Treas.

IPSWICH, MASS.—The people have again voted against works.

NEWBURYPORT, MASS.—The Council has instructed the Mayor to petition the legislature for authority to build works. A supply is now furnished by a company.

WINCHESTER, MASS.—The town has petitioned the legislature for power to issue $100,000 of bonds for extensions.

DANBURY, CONN.—There is talk of enlarging the supply by tapping Bogg's Pond and of filtering the water; estimated cost, $150,000.

WINSTED, CONN.—Address T. C. Richards or Henry Gay regarding bids for improvements in accordance with the Gilbert bequest; surveys have been made.

Middle.

ALBANY, N. Y.—The Water Commissioners have adopted a report of a committee recommending Kinderhook Creek for a new water supply.

BABYLON, N. Y.—The Town Board has awarded franchises to the companies named below: The Babylon Water Co. has a capital stock of $25,000 and will probably put in a direct pressure system; directors, L. H. Fishel, A. J. Woodruff and others. The Amityville Water Co. also has a capital stock of $25,000; directors, J. E. Ireland, Amityville; J. C. Mills, Patchogue; T. M. Griffin, Riverhead, and others.

ROCHESTER, N. Y.—Bids for a new supply conduit about 20 miles long are wanted until Dec. 23, as stated in detail in our advertising columns.

SYRACUSE, N. Y.—The contract for building the distributing reservoir has been awarded to A. Van Wagner & Co., Syracuse. The various bids were as follows: A. Van Wagner & Co., Syracuse, $255,336; Clinton Beckwith, Herkimer, $258,124; John M. Mack, Philadelphia, $200,853; Albert J. Hines & Co., Corning, $202,079; John Moore, Syracuse, $290,045; Troy Public Works Co., Troy, $298,186; Hughes Brothers, Syracuse, $299,443; Francis Curnam Rhinebeck, $328,331; John B. Reiley, Philadelphia, $332,353; John Dunfee and Richard Dawson, Syracuse, $317,863.

IRVINGTON, N. J.—W. H. Glorieux wishes a franchise; proposed supply, wells, with air lift pump.

KEARNEY, N. J.—Consult, Engr., J. A. Lockwood, has reported on a supply from artesian wells, with stand-pipe, as a substitute to the supply now bought of Jersey City. A committee will ask Jersey City for a pure supply, it is said. The East Jersey Water Co. has offered to furnish a supply.

BELTZHOOVER, KNOXVILLE AND LOWER ST. CLAIR, PA.—The Lower St. Clair, Belzhoover and Knoxville Water Co., it is said, will soon want bids for works, Engr. Schnell having prepared plans. Estimated cost, $300,000. C. L. Matthews, Philadelphia, is interested.

Southern.

NEWBERN, N. C.—Wm. E. Clarke, informs us that the Newbern Water Co. will probably let contracts for works early next year. Address Richard P. Williams.

SUMTER, S. C.—The Sumter Water Co. has been or is to be incorporated by Edward F. Partridge, Wm. S. Perot, Jr., H. Bayard Hodge, Joseph S. Keen, Jr., and Joseph W. Hawley, all of Pennsylvania.

BARNESVILLE, GA.—A vote will be taken Dec. 15 on issuing $15,000 6% bonds for works, payable $1,000 each year, beginning Jan. 1, 1907.

JACKSONVILLE, FLA.—Bids will be received until Dec. 15 for a small amount of cast iron pipe. A. F. Harley, Cy. Engr.

North Central.

SPRINGFIELD, O.—The Water-Works Trustees have resolved to ask the City Council to obtain from the legislature power to issue $125,000 of bonds for a new pump and the removal of the pumping station to the reservoir.

LEBANON, IND.—The Council has appointed a committee to investigate and report on works. City ownership is said to be favored.

MARTINSVILLE, IND.—A petition asking the Council to call a water-works election has been circulated. Professor Phillips, of Purdue University, has estimated that works, with a duplicate pumping plant, could be built for $22,000.

ITHACA, MICH.—Nov. 25 a contract for building works was signed by the city and the Lansing Engine & Iron Works; price, $22,195; to be completed July 1, 1893.

Northwestern.

CEDAR RAPIDS, NEB.—The "Commercial" advocates the building of works.

Southwestern.

ST. LOUIS, MO.—Bids are wanted until Dec. 13 for the iron work and gates of Basins Nos. 3, 4, 5 and 6 of the new works. E. S. Foster, Secy. Bd. Pub. Impvts.

CAMERON, TEX.—Works are reported as likely to be built.

CERRILLOS, N. MEX.—The Cerillos Water & Irrigation Co. has been incorporated; $30,000; T. M. Moore, N. B. Shields, A. E. Easley. A franchise was recently granted to Mr. Moore. It is said that water from springs in the San Marcus Arroyo will be supplied by tapping the main of the Atchison, Topeka & Santa Fe Ry. Co.

CLAYTON, N. MEX.—The Clayton Electric Light & Water Supply Co. has been incorporated; $20,000; J. C. Hill, H. C. Pickles, M. W. Boyle and others, all of Clayton.

GLOBEVILLE, COLO.—Wolfe, Webb & Chittenden, Denver, who own land here, are interested in a proposed water company. A franchise may be asked. The proposed company is said to be likely to buy water from the American Water Co., of Denver. G. L. Hudson, Town Attorney.

Pacific.

SPOKANE, WASH.—Bids are wanted until Dec. 26 for a 5,000,000, 4,000,000, 3,000,000, and two 2,000,000-gallon pumps, with boilers; also with waterwheels; bids to be on basis of f. o. b. at factory, and at Spokane, also complete on foundations to be built by the contractor.

MODESTO, CAL.—W. T. Garrett & Co., San Francisco, have offered to build city works after plans made by Engr. J. B. Pitchford, for $60,000. The proposed works include three artesian wells 150 to 200 ft. deep, a well 35 ft. deep, low lift pump, two compound duplex pumping engines, 2,000,000 gallons capacity, two 4½ x 16-ft. boilers and four 30,000-gallon tanks on a 56-ft. brick tower.

SALT LAKE CITY, UTAH.—The Garfield Beach Improvement Co. will tunnel in the canyon for water to supply the new settlement.

Canada.

ST. LAMBERT, P. Q.—Dec. 9 the people vote on issuing $60,000 of bonds for water and drainage.

BROCKVILLE, ONT.—Bids will be received until Dec. 28 for $150,000 4½ 30-year water bonds. G. T. Fulford. Chn. Finance Com.

IRRIGATION.

NEW COMPANIES.—The Northern Water Storage Reservoir, Mining & Milling Ditch Co., Fort Collins, Colo.; $50,000; Alice S. McAnelly, Frank D. and Albert Abbott. Western Land, Irrigation & Reservoir Co., Grand Junction, Colo.; $100,000. Highland Irrigation Co., Los Cruces, N. Mex.; J. H. Nathans, El Paso, S. B. Newcomb, Los Cruces. California Guarantee & Irrigation Construction Co., San Diego, Cal.; $1,000,000; Directors, D. C. Reed, G. T. Christian and others; to buy, sell, build and operate irrigation works. Adams Reservoir, Irrigation & Power Co., Phoenix, Ar'a.; $300,000; Harry W. Adams, Jas. S. Thompson and others; a dam is proposed.

SEWERS.

BOSTON, MASS.—The Superintendent of Streets has been instructed to build sewers in five streets. One will be of brick, 32 × 48 and 30 × 36 ins., and the others from 12 to 18 ins., of earthen pipe.

BROCKTON, MASS.—The Sewerage Commissioners expect soon to be able to report plans for the disposal of city sewage, for which an appropriation of $15,000 was made, as noted in our issue of June 30.

SALEM, MASS.—The subject of a Sewerage Commission for this city and the towns of Beverly, Peabody and Danvers is being discussed. The sewage of these places is now emptied into the Salem harbor, and is washed back again upon the shores of Marblehead and Beverly Farms. The question of disposing of the nuisance is becoming serious, and some definite step will probably be taken before the next legislature.

HARTFORD, CONN.—Luther W. Burt, Cy. Engr., sends us the following information with regard to the present discussion in that city: A number of years ago a trunk intercepting sewer bordering on Park River was proposed, but meantime the sewage has been emptied as formerly into the river and at times has so polluted the pond above the dams, as to render the same offensive, if not detrimental to the health of those living along its borders, and methods for remedying this evil are again being considered.

The subject of sewage disposal in connection with pollution of streams is receiving attention. The city of New Britain, about nine miles distant, empties its sewage into the stream flowing through this city. Within a short time a decision has been rendered by our courts awarding damages to abutting proprietors in the town of Newington, and several years ago this city was compelled by the courts to extend its sewer outlet on the south to relieve the town of Wethersfield.

A plan is now being prepared by the engineering department of this city to show the topography of the city, and upon it is to be delineated, after careful study, a more complete sewage system, comprehending the removal of all sewage from Park River.

BROOKLYN, N. Y.—The engineers of the Department of City Works are considering plans for constructing sewers in the region lying south of Fifteenth St. and south of the Eastern Parkway, between Prospect Park and Ralph Ave. According to Chief Engineer Van Buren, the preliminary plans are based on the hypothesis that the towns of Flatlands and New Utrecht will eventually be added to the city.

BUFFALO, N. Y.—The Board of Public Works will receive bids until Dec. 17 for 10 to 20-in. tile sewers.

CARTHAGE, N. Y.—The plans recently submitted to the State Board of Health were not approved, and it is claimed that it will cost $200,000 to construct the system as recommended by the State Board of Health.

JAMESTOWN, N. Y.—A special election will be held Dec. 15 to vote on the issue of bonds for $160,000 to construct the proposed system of sewers. It has been decided to pay for the system entirely by city bonds.

NEW YORK, N. Y.—The Commissioner of Public Works will receive bids until Dec 15 for sewers in four streets. The Commissioner of Street Improvements of Wards 23 and 24 will receive bids until Dec. 15 for sewers in two streets.

ROCHESTER, N. Y.—City Surveyor McClintock has submitted a partial report of additional sewers needed in order to derive the greatest possible benefit from the East Side trunk sewer. It is thought that this trunk sewer will be completed within a year, and at a cost considerably less than the estimate of $1,000,000. About five of the eight miles are already under contract.

STAMFORD, N. Y.—At a special election Nov. 30 the citizens voted in favor of issuing bonds for the proposed sewers. The plan adopted proposes a complete system with disposal works, at an expense of $20,000. The disposal works and the outlets are to be constructed at a public expense of $12,000, and the balance to be assessed upon property owners. It is expected that the system will be completed by July next.

TROY, N. Y.—The Board of Contract will receive bids until Dec. 16 for taking up and rebuilding the brick sewer in Federal St., from Maiden Lane to the Hudson River.

ORANGE, N. J.—The City Clerk will receive bids until Dec. 15 for $256,000 of sewer construction bonds. C. P. Bassett, Engr., estimates that the total cost of the sewer system will be between $850,000 and $925,000, including the full cost of the outlet sewer for which $100,000 will be repaid by the townships of Bloomfield and Montclair. About $50,000 will be assessed directly on the property for house connections, and $100,000 will be assessed on the property benefited. Bonds for $484,000 have already been issued.

ROSELLE, N. J.—At a special election Nov. 28 the citizens voted to issue bonds for the proposed trunk sewer, for which plans were recently prepared by C. P. Bassett. The sewer will be about four miles long and empty in tide-water near Elizabeth. The estimated cost is $50,000, and bids will soon be asked for the construction.

PHILADELPHIA, PA.—The Director of Public Works will receive bids until Dec. 12 for main sewers in three streets.

PITTSBURG, PA.—The City Council has passed ordinances for sewers in eight streets.

READING, PA.—At a special meeting Dec. 1 the reports of Col. G. E. Waring, on a system of house sewage for the city were considered. Owing to the high elevation of the poor house farm, referred to in our issue of Nov. 3, he recommends the disposal of the sewage by downward intermittent filtration on Yost's Island on the Schuylkill, two miles below the city. The higher part of this island can be reached by gravity from a sewer low enough to receive the drainage of nearly the entire city. A 24-in. pipe is recommended and provisions for a duplicate pipe should the growth of the city require it. The pipe is to extend along the old Union Canal either on trestle work or underground. A plan was also submitted to carry the sewage in an open aqueduct, 3 × 3 ft., which would receive the sewage at the other side of the W. & N. bridge, to which point it would be carried in two 20-in. pipes. The estimated cost of the system is about $375,000, as according to the plans of Mr. Bassett, which Colonel Waring approves. The cost of preparing the island for the receipt and distribution of the sewage it is thought will not be over $10,000, the main work being the construction of distribution channels and barriers and the construction of dry roadways for removal of the crops. It would cost less than $5,000 to construct a pumping plant for that portion of the city whose drainage could not be removed by gravity.

LOUISVILLE, KY.—The Commercial Club has decided to undertake a sanitary survey of the city, independently of the City Health Board. The estimated cost is $500, and the work will be done as soon as possible.

AVONDALE, O.—The Village Engineer has been directed to prepare plans for sewering district No. 2, east of Reading road and south of Ridgeway Ave.

INDIANAPOLIS, IND.—The Board of Public Works has taken the first steps toward constructing the system of sewers proposed some time ago. Estimates have been prepared for sewers as follows: Washington St., 8,342 lin. ft., 20×30 to 36×54 ins., estimate, $69,055; main intercepting sewer, 7,166 lin. ft., 54 to 60 ins., $125,000; eastern branch of main intercepting, 7,118.5 ft., 18 to 54 ins., $55,000; Mississippi St., 14,485 lin. ft., 12 to 96 ins., $200,000; Alabama St., 3,970 lin. ft., $21,000; Merrill St., 4,000 lin. ft., $16,000. The estimated cost of building the main sewer is as follows: Excavation, $59,906; brick, $127,006; house connections, $1,544; catch basins, $5,220; manholes, $1,000; concrete, $18,200; masonry, $350; piling, $84; sheeting, to be left in, $2,100; timber foundations, $61; lateral sewer connections, $2,632; interest and contingencies, $32,724; total, $250,889.

CHICAGO, ILL.—The Commissioner of Public Works will receive bids until Dec. 13 for sewers in nearly 50 streets. The sewer in 73d St. was completed Dec. 1. It is about 25,000 ft. in length, 6 ft. in diameter, and cost $265,724. Work was commenced Sept. 15, and 2,000 men have been employed. The depth of excavation was from 10 to 16 ft.

OMAHA, NEB.—The Board of Public Works will receive bids until Dec. 16 for sewers in two districts.

SEATTLE, WASH.—Plans are being prepared for an extension of the Lake Union sewer tunnel. The main extension will have a diameter of six feet and there will be two 4-ft. branches. The lining will be of brick the same as the main tunnel.

STREETS.

BOSTON, MASS.—The Board of Aldermen has passed an order appropriating $125,000 for paving material.

BOSTON, MASS.—The Board of Park Commissioners will receive bids until Dec. 12 for grading on the Parkway, between Washington St. and Forest Hill St.

NEW YORK, N. Y.—The Commissioner of Street Improvement of Wards 23 and 24 will receive bids until Dec. 15 for grading, curbing, etc. Special commissioners have been at work for about ten weeks on plans for a new street called Cathedral Parkway, which will unite Central Park, Morningside Park and Riverside Park in one continuous driveway. The road will be under control of the Department of Parks, so that trucks and heavy teams will be excluded from it.

CLEVELAND, O.—By the will of the late W. J. Gordon, the city has recently become the recipient of a large park. A boulevard to connect this park with Wade Park is proposed, the distance varying from 15,200 to 29,000 ft., according to the route. It is thought that a desirable boulevard can be constructed for $50,000 a mile.

DAYTON, O.—The city authorities have decided to construct ten miles of street paving next year, at an estimated cost of over $500,000.

TOLEDO, O.—Bids have been received for five contracts. The lowest bids for paving Door St. were as follows: H. P. Streicker, Medina stone, $90,338; cedar blocks, $37,551 or $38,508, for Berea or Medina curb, respectively; fire brick, $43,670 or $44,633; asphalt blocks, $90,704 or $91,961; Wm. McMahon, Hallwood blocks, $54,115 or $54,888; Warren-Scharf Asphalt Paving Co., Trinidad asphalt, $59,299 or $60,130. The lowest bidders for the other contracts were Wernet & Son, Wm. McMahon and C. W. McKinney, except that the bid of the Warren-Scharf Asphalt Paving Co. was the lowest on each street for Trinidad asphalt.

VENICE, ILL.—The Village Board has decided to raise the grade and reconstruct Main St., using brick for pavment.

FORT HOWARD, WIS.—We are informed by Geo. H. Randall, C. E., that the $15,000 of bonds, to which we referred last week, have been issued to pay for the city's portion of the work done the past season. The city has spent about $80,000 for paving and sewers during the past summer.

DENVER, COLO.—City Engineer Merryweather reports that the proposed paving of Cleveland Place will cost $17,470, and of Court Place, $29,000.

LEWISTON, IDAHO.—The contract for grading Main St. has been awarded to S. M. Harrington, at between $10,000 and $12,000.

GALVESTON, TEX.—Bids are asked until Dec. 17 for paving about 60,000 sq. yds. with creosoted long leaf yellow pine blocks, ten pounds of dead oil to be used to each cubic foot of timber. H. T. Wilson, Cy. Engr.

OAKLAND, CAL.—The Board of Public Works has instructed the Secretary to advertise at once for bids for the boulevard around Lake Merritt in accordance with the plans of T. W. Morgan, Cy. Engr. The first section of this boulevard, consisting of a stone wall about 2,000 yds. in length and 100 ft. from the shore, was completed before the people had voted against the issue of bonds for the boulevard. The Board of Health, however, has declared that the lake must be dredged, and as there is no better place to put the mud than behind the boulevard wall, the Board of Public Works has voted to continue the construction.

WINNIPEG, MAN.—The Committee on Works will receive bids until Dec. 22 for 800 cords of cedar block paving wood.

ELECTRICAL.

DEERING, ME.—A contract has been awarded to the Westbrook Electric Light Co. for 28 arc lights, at $100 per light, for one year.

BATAVIA, N. Y.—At a special election Dec. 2 the taxpayers voted against the village ownership of an electric light plant, referred to in our issue of last week. The Batavia Electric Light Co. has submitted three new propositions, the one receiving the most favor being to furnish 20 all-night lights and 53 lights till midnight at a cost of $5,445 annually.

CASTILE, N. Y.—The business men of this place are making an effort to introduce electric light.

FRANKLINVILLE, N. Y.—The question of electric lighting is reported as being discussed with favor. The plan is to organize a private stock company and put in a plant to cost $10,000.

ITHACA, N. Y.—A syndicate from Scranton, Pa., has purchased the stock of the electric street railway and electric light company. About $50,000 is being expended in the Fall Creek gorge in preparing a site for the water-power which is to drive the dynamos for the railway and light plants.

PHILADELPHIA, PA.—The following bids were opened Dec. 5 for lighting the city by electricity during the year 1893: Frankford Ave. & Merchants' Co., 45 cts.; Philadelphia Illuminating Co., 38 cts.; Wissahickon Electric Light Co., 50 cts.; Germantown Electric Light Co., 55 cts.; Powelton Ave. Electric Light Co., 47 cts.; Suburban Electric Light Co., 55 cts.; Diamond Electric Co., 45 and 50 cts.; Southern Electric Light Co., 40, 45 and 50 cts.; Brush Co., 40 and 42.5 cts.; for cables, 30 cts.; U. S. Electric Light Co., 42.5 cts.; Manufacturers' Electric Light Co., 45 and 50 cts. These prices are lower than those paid for the lighting during the current year.

ELIZABETH CITY, N. C.—The Elizabeth City Electric Light Co. will increase the capacity of its plant.

CARROLLTON, GA.—A special election will soon be held to vote on the issue of bonds for enlarging the electric light plant and for water-works.

NASHVILLE, TENN.—The City Attorney has been directed to frame a bill to be introduced into the legislature authorizing the city to issue bonds for $150,000 to establish an electric light plant, at the city's discretion.

GALLIPOLIS, O.—The citizens have voted almost unanimously in favor of electric lights.

HURON, O.—Solomon Kriss is reported as about to put in an electric light plant.

DES MOINES, IA.—The plant of the Des Moines Water Power Co. was destroyed by fire Nov. 30, causing a loss of $50,000. The capital stock of the company is $200,000, and the plant will probably be rebuilt immediately.

SOUTH OMAHA, NEB.—An electric light plant will be erected to cost $30,000. J. A. McShane, E. A. Cudaby and Wm. A. Paxton are interested.

BOULDER, COLO.—A new electric light company has been organized with a capital stock of $100,000. The company intends to put in a large Corliss engine and several dynamos. The dynamos are to be used, first, for the extraction of mineral from ores by a new process, and second, to furnish the city and the citizens with electric light. A bid for street lighting will soon be submitted to the City Council. Gen. Man., W. K. Mehollin, who is the patentee of the extracting process; Pres., Geo. R. Chavey; Vice-Pres., Geo. A. Goddard; Secy., Eugene Wilder.

LOS ANGELES, CAL.—The contract for lighting the city for two years from Jan. 1, 1893, has been awarded to the Los Angeles Electric Co. at $11.50 per month for each 2,000-c. p. light, and $17.25 for each 3,000-c. p. light.

RIVERSIDE, CAL.—The Redlands Electric Light Co. proposes to supply light and power in this place.

WALLA WALLA, WASH.—The City Clerk will receive bids until Dec. 20 for street lighting for one or three years.

NEW COMPANIES.—Flatlands Electric Light & Power Co., Flatlands, N. Y.; $50,000; M. L. Towns, Francis Gross, H. A. Gerhardt, Jr. Cinnaminson Electric Light, Power & Heating Co., Riverton, N. J.; $50,000; H. V. Massey, Philadelphia, Pa.; M. B. Perkins, Beverly; I. E. Maguire, Palmyra. Everett Light, Heat & Power Co., Everett, Pa.; $15,000; Treas., H. H. Hill. Clayton Electric Light & Water Supply Co., Clayton, N. Mex.; $20,000; J. C. Hill, M. W. Boyle, R. P. Erveine.

CONTRACT PRICES.

SEWER TUNNEL.—Niagara Falls, N. Y.—Bids were opened Nov. 25 for a trunk sewer, in tunnel, approximately 5,000 ft. long, with a diameter of 8 ft., and to be 45 ft. below the surface. There will be a shaft at the portal, and one each at about 1,406 ft., 3,322 ft., and 5,000 ft. distant from the portal. The invert will be lined throughout and the tunnel and shafts will be lined with masonry where the nature of the rock makes this necessary. The total bids were as follows: 1, Chas. Donoghue & Co., $132,114 or $121,952, according to plan; 2, Chambers & Casey, $143,615 or $130,899; 3, Theo. Kandeler, $131,758 or $174,048. The estimate of the City Engineer, E. Z. Burns, was $138,681 or $126,056.

Work.	1.	2.	3.
Sinking shafts, 895 cu. yds...	$9.00	$9.00	$18.50
Raising shafts, 100 cu. yds...	10.00	12.00	23.00
Tunnels, 5,018 lin. ft.....	19.00	19.50	25.00
Trenching, 590 cu. yds.....	2.25	3.00	2.75
Masonry, 402 cu. yds.....	9.00	12.00	14.00
Lining, No. 1, 4,429 or 2,000 lin. ft.....	3.50	4.50	6.25
Lining, No. 2, 526 or 300 lin. ft.....	10.00	11.00	10.50
Furnishing iron, etc.....	1,700.00	3,800.00	3,300.00
Extra brick, 16 cu. yds.....	10.00	14.00	15.00
Extra concrete, 25 or 125 cu. yds.....	6.00	7.00	12.00

MISCELLANEOUS.

DOCK.—Duluth, Min.—It is reported that the Duluth & Iron Range R. R. will award a contract Jan. 1 for a new ore dock at Two Harbors, for the exclusive handling of Mesaba ore. The dock is to be 2,00 ft. long and contain 282 pockets, with a capacity of 45,000 tons.

LEVEE WORK.—New Orleans, La.—Bids will be received at the U. S. Engineer Office until Dec. 19, 21 and 23, for levee work. Capt. John Millis, U. S. A.

REMOVING WRECK.—Newport, R. I.—The following bids were opened by Capt. W. H. Bixby Dec. 3, for removing wreck of steam yacht Alva: C. W. Johnston, Del., and E. Townsend, Somers Point, N. J., $12,395; Chapman Derrick & Wrecking Co., New York, $16,874; C. J. Kelley and G. S. Vansant, Atlantic City, N. J., $5,916.

CITY HALLS.—Jersey City, N. J.—The contract for the new city hall has been awarded to C. A. Bouton & Co., at $236,750. It is expected that the building will be completed by April, 1894.

Milwaukee, Wis.—We are informed by G. H. Benzenberg, Cy. Engr., that the lowest bids for the city hall were as follows: A. Johnson & Bros., Chicago, Ill., all the work except piling, $721,000; J. O'Neil, Milwaukee, pile driving, $13,096, being 16.4 cts. per lin. ft.

SEA WALL.—Tompkinsville, N. Y.—Proposals for the construction of the masonry sea wall at the U. S. light-house depot, Staten Island, will be received until Dec. 21, by Maj. I. P. Heap, U. S. Light-House Engineer. The amount available for the work is about $25,000.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Baldwin Locomotive Works, Philadelphia, Pa., have delivered 30 ten-wheel engines to the Missouri Pacific, and are building 4 passenger engines for the Richmond & Danville. The Brooks Locomotive Works, Dunkirk, N. Y., are building 10 ten-wheel passenger engines for the Lake Shore & Michigan Southern. The Chicago & South Side Rapid Transit has purchased 12 more engines. The Franklin & Abbeville (Franklin, La.), will purchase a locomotive. The Baltimore & Ohio has placed three Baldwin express passenger engines on its Chicago Division; cylinders 10×24 ins. driving wheels 6 ft. 6 ins. diameter, weight 113,000 lbs. The Ohio Southern will place orders for four passenger and 10 mogul freight engines, weighing 52 tons.

CARS.—The Duluth Mfg. Co., Duluth, Minn., has built 500 ore cars, 25 box cars, 2 cabooses, and 6 passenger cars for the Duluth, Mesaba & Northern. The Lamokin Car Works, Lamokin, Pa. (E. H. Wilson & Co., Philadelphia), have orders for a number of street cars, including one for the Atmospheric Propulsion Co., New York. The Michigan Peninsular Car Co. had its works at West Detroit, Mich., destroyed by fire Nov. 25. The Chesapeake & Ohio has placed orders for 1,000 box cars and 1,000 coal cars. The Nashville, Chattanooga & St. Louis has added 300 freight cars to its equipment. The Ohio Southern will place orders for 10 passenger cars. J. H. Burckhalter, Augusta, Ga., wants a second hand combination coach, one box and one flat car. The Delbert Engineering Co., New Orleans, La., wants 200 cars for sugar plantation work.

RAILWAY SHOPS.—The Southern Pacific will move its shops from Carlin and Terrace to Ogden, Utah. The Illinois Central has a large force of men at work on its new round house at Centralia, Ill. It will accommodate 40 locomotives and will measure 350 ft. in diameter. The Georgia, Carolina & Northern will build railway shops at Abbeville, S. C., in consideration of the donation by the citizens of a site and a bonus of $15,000.

IRON WORKS.—The Calumet Steel & Iron Works, on the Calumet River, near Cummings, Ill., have been sold to a syndicate of Cleveland men, and work will be resumed on the plant, which has been idle for the last year. A. M. Wilcox, of the firm of Cleveland, Brown & Co., is at the head of the syndicate, and has been elected its president.

DICK, KERR & CO., London, England, contractors for street and steam railways, are preparing to introduce their appliances in this country, and to bid upon any work in their line. The firm manufactures light railway material and equipment, and makes a specialty of track for electric and cable railways. It is sole proprietor of the cable patents in England, and among other roads constructed are the Edinburgh & Northern Tramway and the Brixton extension of the London Tramway. Its construction of cable railway track was described and illustrated in our issue of July 20, 1889.

THE RIEHLE BROS.' TESTING MACHINE CO. has recently removed to its office and wareroomes from 413 Market St. to 19 N. 6th St., Philadelphia, where will be kept an assortment of the articles manufactured by this company, such as, testing machines (the smaller sizes), Riehle-Robie patent friction ball screw jacks; extra heavy warehouse and railway trucks, etc. This company at the new store, carrys on an extensive contractors' supply business, and has for sale, in addition to its own products, iron, steel and wooden wheel barrows; iron wheels and castors, hand carts, special trucks and the Clark patent rubber wheels and castors. Parties wishing tests of materials made can leave the specimens at this store, instead of taking them to the physical laboratory connected with the works at 9th and Master Sts., Philadelphia.

THE CONSOLIDATED CAR-HEATING CO., Albany, N. Y., has declared a semi-annual dividend of 1½%, and has changed the titles of some of its officers. The Vice-President and Treasurer reported at the meeting on Dec. 6 that the business of the company averaged over $1,000 a day for the past 18 months.

NEW COMPANIES.—Hadduck Railway Material Co., Chicago, Ill.; $20,000; Frederick W. Moore, J. E. Plumb and F. W. Pringle. Cincinnati Contract, Construction & Improvement Co., Covington, Ky.; $50,000; E. F. Abbott and B. R. Morton.

CURRENT PRICES.

RAILS.—New York: $30 at eastern mills, $30.75 at tidewater; girder rails, $36 to $39; old rails, $17 for iron, and $14.50 to $15 for steel. Pittsburg: $30; old rails, $21 for iron and $15.50 to $16.50 for steel. Chicago: $31 to $32.50; light rails, $32; old rails, $18.50 for iron, and $13 to $14.50 for steel.

TRACK MATERIAL.—New York: steel angle bars, 1.6 to 1.65 cts.; spikes, 1.9 to 2 cts.; track bolts, 2.4 to 2.6 cts. with square and 2.7 to 2.8 with hexagon nuts. Pittsburg: splice bars, 1.75 to 1.77 cts. for iron and 1.8 cts. for steel; iron and steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.75 to 1.8 cts. for iron and steel; spikes, 2.05 to 2.1 cts. at mill; track bolts, 2.65 to 2.75 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows at Pittsburg: 55% and 10%, and 47½% and 10% on black and galvanized butt welded; 65% and 10%, and 55% and 10%, on black and galvanized lap welded. Casing, 57½%.

FOUNDRY PIG IRON.—New York: $13.25 to $15. Pittsburg: $13 to $14.25. Chicago: $13.25 to $14.25.

LEAD.—New York: 3.7 to 3.75 cts.; Chicago: 3.72 to 3.75 cts.; St. Louis: 3.5 to 3.55 cts.

STRUCTURAL MATERIAL.—New York: beams, 2.15 to 2.5 cts. for large lots, and 2.35 to 2.75 cts. for small lots; channels, 2.2 to 2.5 cts.; angles, 1.85 to 2 cts.; tees, 2.2 to 2.75 cts.; sheared iron plates, 1.85 to 2.1 cts.; steel plates, 1.85 to 2 cts. for tank, 2.2 to 2.25 cts. for shell, 2.5 to 2.65 cts. for flange, 2.7 to 2.8 cts. for firebox. Pittsburg: beams, 2 to 2.1 cts. for large lots, and 2.2 to 2.25 cts. for small lots; channels, 2 to 2.1 cts. for large lots, and 2.2 to 2.25 cts. for small lots; angles, 1.85 to 2 cts.; tees, 2.25 to 2.35 cts.; Z-bars, 2 to 2.05 cts.; universal mill plates, 1.75 to 1.85 cts. for steel; sheared steel bridge plates, 2.1 to 2.25 cts; refined bars, 1.7 cts. for iron and steel; steel plates, 1.75 to 2 cts. for tank, 2 to 2.25 for shell, 2.1 to 2.2 cts. for flange, 3.5 to 3.75 cts. for firebox, 2 to 2.1 cts. for bridge. Chicago: beams, 2.25 to 2.35 cts., for large lots, and 2.45 to 2.75 cts. for small lots; channels, 2.27 to 2.35 cts. for large lots, and 2.45 to 2.75 cts. for small lots; angles, 1.9 to 2 cts.; tees, 2.2 to 2.3 cts.; universal plates, 2 to 2.1 cts.; steel plates, 2.05 to 2.15 cts for tank, 2.12 to 2.25 cts. for shell, 2.25 to 2.4 cts. for flange, 2.7 to 2.8 cts. for firebox.